NATURE

No. 4250 SATURDAY, APRIL 14, 1951 Vol. 167

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Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
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Telephone Number: Whitehall 8831
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Advertisements only should be addressed to:
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2.
Telephone Number: Temple Bar 1942

The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad.

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TRAINING OF METALLURGISTS

SINCE 1948 the Joint Committee on Metallurgical Education, consisting of representatives of professional bodies, the metallurgical industries, the universities and the technical institutions of Great Britain, has been considering that section of metallurgical education which is based on university and other full-time courses. Its report, which has now been published*, is based on its opinion that the higher technological education of metallurgists can best be provided at universities, and is concerned in the main with those who will go into the actual works rather than into research laboratories and the like.

Many leaders of the metallurgical industries have given much time and thought to answering the Committee's questions, and it is clear that university education and its bearing on the supply of suitably trained men are recognized as matters of major importance.

The Committee is clear that most graduates have a good knowledge of basic science and its application to metallurgy: they mix well with their fellows, and, in the main, show a responsible attitude towards their work. The Committee regards the following points, however, as needing particular emphasis. There is unanimous agreement that the ability of university graduates to write clear and concise English is much less than might be reasonably expected, and has, in fact, been described as "deplorably low". The Committee does not consider that the teaching of English should be the responsibility of the university schools of metallurgy; but it believes that the university courses might well include instruction and practice in the writing of reports, technical papers and the like.

The present policy of some universities of admitting students at the end of the 'intermediate' year may be necessary until the present congestion is relieved. The Committee is, however, strongly of the opinion that the teaching of 'intermediate science' should normally be the function of the universities themselves, and, therefore, that the undergraduate course in metallurgy should be for four full years duration, both for pass as well as honours degrees. Its view is equally strong that some instruction in the humanities should form part of the syllabus in the 'intermediate' year.

There is some evidence that the universities may be pressed to give more instruction in the practical details of various metallurgical processes than they do at present; but this tendency should be resisted. The university course should provide a sound knowledge of the relevant fundamental sciences and illustrate their application over a fairly wide range of metallurgical operations. At the same time, it is desirable that the undergraduate should also gain some acquaintance with the technique of his subject; this is best acquired, however, by practical work in industry during vacations. In this the metallurgical industries must co-operate in providing the necessary opportunities.

* Joint Committee on Metallurgical Education. Recommendations on University Full-Time Degree Courses in Metallurgy. Pp. 11. (London: Iron and Steel Institute, 1950.)

The universities should also resist any tendency in the opposite direction. Although it is a first essential that every attention be paid to giving the soundest possible grounding in basic science, it must be remembered that the undergraduate taking a course in metallurgy does intend to enter that profession and to apply his knowledge to practical processes. It is important, therefore, to hold his interest, which will be centred on the technology of the profession he has selected. Although the Committee believes that the teaching of the basic sciences in the different universities should be maintained at a high level, it is neither necessary, nor even desirable, that there should be uniformity. The illustrations from practice, by which the teaching of metallurgical science is facilitated, may properly be biased by the type of metallurgical industry established in any particular neighbourhood.

A degree in metallurgy should imply the ability to read technical literature with reasonable ease in at least one foreign language; facilities to enable this standard to be reached should be available as a recognized part of the university course, and proof of this proficiency should be demanded before a degree is conferred.

The Committee has no doubt regarding the great advantages conferred by residence at a university, even if, as a start, this is possible for only, say, one out of the three or four years of the university course. It realizes also that the universities themselves are most deeply concerned with this, and trusts that their ambitions to obtain adequate residential facilities will be achieved.

Both the industry and the graduate must accept the fact that the latter is at first only a metallurgical learner. The industry must not expect too much from the graduate for the first year or two, and he in his turn must realize that when he first enters industry he has still to acquire the requisite knowledge of the technique of whatever branch of metallurgy he has chosen. The Committee notes with satisfaction that this fact has now been widely accepted, and that industry to day is much more disposed than at any previous time to regard the young graduate as a paid learner, whose further training is its own responsibility. The universities, however, should also do everything possible to see that the undergraduate does obtain the right kind of practical work in industry during vacations, and that such work is graded so as to provide the type of experience which the student is able to absorb at his particular level of metallurgical education. By this means the graduate in metallurgy would be enabled to enter industry equipped not only with a body of fundamental knowledge but also with a modicum of practical experience which would be invaluable in enabling him to bridge the gap between university studies and industrial life.

The student metallurgist having received his training, the question of his employment arises. The Ministry of Labour and National Service has published a report* of a sub-committee, under the chairmanship of Sir William Griffiths, of Lord Hankey's Technical Personnel Committee. It is concluded that during the five years ending in 1954 some 1,350 metallurgists, either with a university degree in metallurgy or with an equivalent professional qualification, will be required. Against this it is anticipated that a thousand such metallurgists will qualify during that period with at least a pass degree. In other words, the supply during the next five years will not satisfy the demand.

The number of trained metallurgists available for research and teaching seems likely to be adequate, and the shortage will be felt in those sections of industry dealing with production and development. It is scarcely surprising, therefore, that the view has been expressed to the Committee that, if a career in industrial production is contemplated, students should be encouraged either to leave college immediately after graduation, or to spend any further time in studies "more helpful to their future work than those now generally considered necessary for Honours degree preparation". Such steps, by shortening the time between entering the university and becoming fully useful in industry, would help to accelerate the supply in the immediate future. There is also an implication that the Committee has been pressed to support a university course of a more directly industrial character than that at present normal. This possibility was in the mind of the Joint Committee on Metallurgical Education, and its considered opinion was that "this tendency should be resisted".

Among the conclusions reached is that "active and urgent consideration should be given by those concerned to the question of whether the training of metallurgists intending to enter industry is best suited to the needs of the times". To this no objection can be taken; but it is only fair to point out that this matter has been under both "active and urgent consideration" by the Joint Committee on Metallurgical Education at least for the past two years, and definite conclusions have been reached.

* Ministry of Labour and National Service: Technical and Scientific Register. Present and Future Supply and Demand for Persons with Professional Qualifications in Metallurgy. Pp. 16. (London: H.M. Stationery Office, 1951.) 4*d*. net.

PSYCHOLOGY OF BEHAVIOUR

The Springs of Conduct

A Neuropsychological Study. By Sir John Parsons. Pp. viii+104. (London: J. and A. Churchill, Ltd., 1950.) 7*s*. 6*d*.

IT is a pleasure to record the publication of this brief, but exceedingly interesting, book by Sir John Parsons. His aim, he says, was "to urge the importance of the greatly increased knowledge of the functions of the nervous system with respect to human conduct; or in other words, to correlate knowledge derived from physiology with the vast body of psychological knowledge". Obviously the field for exploration is enormous. It covers the whole history of the development from very simple beginnings of the most complex types of behaviour. It demands an evaluation of the critical turning-points in this development. It calls also for a very wide knowledge and a just and critical appraisement of a large variety of philosophic and scientific views.

The whole essay can be read in an hour or two, though it will probably need to be re-read several

times by anyone who is fully to appreciate its significance. The pace set in its ninety-five pages is swift, almost breathless. But the book moves easily, decisively from point to point, and it shows—just as the publication twenty-three years ago of the "Introduction to Theory of Perception" showed—that its author possesses the rare distinction of being able to enhance a reputation firmly founded upon more specialist studies, by discussions of the broadest and most fundamental issues.

Like many another, Sir John is disturbed by the tremendous growth of minute specializations in modern science and technology. Preoccupation with day-to-day advances may obscure the wide view which alone can reveal the decisive relationships of broadly differing groups of phenomena and of theories concerning them. He therefore begins with a very general "historical introduction". This is, in fact, altogether too hurried. Nobody will make much of its catalogue of theories and their authors, who has not already a mind well stored with historical knowledge.

There follows a chapter on comparative psychology. This is far more effectively informative. It distinguishes "three stages of mind—the sentient, the perceptive, and the conceptual" (p. 10). The first is largely dependent upon varieties of 'affect' or feeling tone, the second upon instinct and emotion, and the third—made possible especially by the acquisition of 'distance receptors', erect posture and binocular vision—upon intelligence, with its principal functions of abstraction and generalization. No succeeding stage can ever entirely escape from the determinant influences which operated at an earlier period, but must somehow work these influences into its own ways of dealing with its environment.

Now comes a discussion of physiology. It is the longest, and many readers are likely to find it the most satisfying, part of the whole essay. In the main it is a brilliantly illustrated plea for a return to a more fundamental consideration of the significance of the work of Sir Charles Sherrington (a theme which runs through the whole of the rest of the book), with occasional excursions to glance at the discoveries or opinions of Edinger, Herrick, Ariens Kappers and Hughlings Jackson, at the more recent investigations of brain activities by Penfield, Adrian and Denis Williams, and finally, and not very enthusiastically, at the psychopathological work of Freud. The reader who knows little about these developments will be driven, to his great gain, to the original publications, which are always indicated. The reader who does know about them is likely, equally to his gain, to be reminded of many vital points which he had forgotten or overlooked. The course of the exposition is set by its main title, "From Reflex to Concept".

The next three chapters are all mainly psychological and deal respectively with the integration of the individual, the role of reason and the tyranny of emotion. The leading general notion, perhaps, is to show how even what are usually regarded as the highest mental achievements cannot escape from those characters of affect, emotion and instinctive and impulsive action which come from the earlier stages of animal development. Thus, for example, the normal human individual has to try to express a lot of different interests or predispositions all at once in relation to whatever group of stimuli from his immediate environment he must endeavour to deal with. A study of the constitution of the individual, then, requires consideration of 'herd instinct', egoistic and altruistic action, leadership, the character of moral judgments, public opinion and the 'group mind'; and all these matters are considered, though only very briefly. Similarly with reason: if, in its development, it attempts to cut adrift from its own history, it runs into a lot of misfortune by becoming over-rationalized.

The tyranny of emotion can be exercised in many ways, but especially when systems of ideas which have to do with practical affairs (the kind nowadays often called 'ideologies') are being propounded, strong feelings rush out of their hiding-places and set up a barrier between one such idea-system and all others.

The final chapter is called "The Influence of Neurology on Psychology". What it indubitably shows is that psychology began to move into the realms of science only when it started to build its methods upon those other and more experimental attempts to study the structure and functions of behaviour best represented by physiology and neurology.

This is true and important. Yet its main significance seems to be that it points clearly to the methods and canons which the psychologist must use in his own fields if he is ever to replace speculation by warrantable knowledge. Some stubborn questions still remain. Often, throughout the essay, it seems as if some general, highly conventional, and pre-experimental psychological scheme is being accepted without question; and then it is maintained that the scheme is not only not inconsistent with the discoveries of physiological and neurological research, but loses its speculative character if it is set in the light of these discoveries.

Such an argument is bound to leave some psychologists a bit unhappy. Why is it that many (though, fortunately, not all) of the growing number of physicists and physiologists who are interested in human behaviour are willing to take no end of trouble to investigate scientifically all the processes that lie within their own special fields, but treat the psychological processes proper as if they need no similar investigation because everybody knows without searching what they are? Only if the 'mental' processes are investigated in their own right and with equal loyalty to scientific demands is it likely that their underlying physiology and neurology can ever be understood in more than a very wide and generalized manner.

For all this, Sir John Parsons has written a timely and valuable essay, full of knowledge and wisdom. It is greatly to be hoped that it will be read widely and its lessons taken seriously to mind.

F. C. BARTLETT

NORTH AMERICAN FORESTRY

Applied Silviculture in the United States

By Prof. R. H. Westveld. Second edition. Pp. xi+590. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 48*s*. net.

THE author's chief reason for producing a second edition of this useful work is stated to be the great change that has taken place in the value of money during the ten years that have elapsed since the book was first published. This has rendered the original data for costs rather meaningless, and he has advisedly converted them into man-hours of time, or has used ratios to show relative instead of absolute

values. During the ten years, despite the preoccupation of foresters, like all other sections of the community, with war-time and immediate post-war problems, there has been a considerable accumulation of additional information affecting silvicultural knowledge and techniques; but it does not appear that very far-reaching changes have been necessitated. More influential, however, has been the development of markets for relatively low-quality wood, giving a value to hitherto unsalable species and to smaller or poorer material of already marketable species; this in turn makes possible silvicultural operations which involve expenditure beyond the value of the material cut, though, of course, the greatly increased cost of labour works in the opposite direction.

One might quarrel with the title adopted, as it is difficult to think of silviculture, in the literal sense of the word, as being other than 'applied'; but Prof. R. H. Westveld is contrasting the field he is treating, which we might describe as silvicultural practice, with the basic knowledge which must precede and underlie it. The book is intended to be a text-book, and a knowledge of the foundations of silviculture (or 'silvics') is presupposed, as well as familiarity with regeneration, slash disposal and planting methods. The author also recognizes that measures which are silviculturally the best for the stand under consideration may have to be modified in practice in the light of other management objectives such as watershed or wild-life protection.

The author has been engaged in silvicultural research in three widely separated and very different regions of the United States—the Pacific north-west, the Lake States and the south-east—and this, with his long experience of teaching and opportunities for comprehensive study of the vast amount of literature, has made it possible for him to survey the silvicultural conditions and practices of the great range of forest types occurring in the United States. It was a wise precaution, in view of the magnitude of the task, that the chapters dealing with the several regions have been submitted to local experts for check. In view of the tendency of authors to adopt their own nomenclature for trees and types, it is satisfactory to find that Prof. Westveld adheres strictly to a generally available standard check-list and type classification.

The treatment of the subject adopted is to deal with the eighteen regions in turn, giving for each a general description and history with notes on management and the forest types occurring. Then, for each type the available information is given under a standard series of heads, such as ecological notes and status, regeneration conditions, utilization and markets, growth and rotation, financial aspects, silvicultural practices, slash disposal and pathology. A list of references is given to the literature for each region, and this forms one of the most useful features of the work, though the average student might have preferred a more selective list. There are author and subject indexes at the end of the book which would have been more helpful had the more important page-references been indicated among the couple of dozen one may find.

This second edition will be of great value, not only to the forest schools and colleges but also to all who follow the progress of silvicultural practice and forest management in the United States, both for its general professional interest and for stimulating suggestions for dealing with the comparable problems that face the practitioner everywhere. H. G. Champion

LABORATORY MANUAL OF INVERTEBRATE TYPES

Selected Invertebrate Types
Edited by Frank A. Brown, Jr. Pp. xx+597. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 48*s*. net.

WRITTEN and illustrated by thirteen zoologists as a laboratory manual, this work deals with more than one hundred animals selected from all the invertebrate phyla and the Protochordata. The species are American, but most of the book can be adapted with little change for use in Great Britain. Although intended for undergraduates, the book will be found useful to the university lecturer, as well as to the experimental biologist, because it will suggest suitable animals for his studies. To this end the short anatomical descriptions are frequently accompanied by notes on mode of life, conditions necessary for keeping the animals alive (such as *p*H of the aquatic medium, temperature and salinity, etc.), methods of treating the material and cultural hints.

With so many authors there is bound to be inequality. Each author uses his own method of presentation and illustration, and, while this no doubt stimulates the student and avoids a dead level of uniformity, it does involve time for the adjustment of the reader's powers of apprehension. Thus, in the illustrations one author prefers a fully labelled drawing, a second uses numbers for the organs, a third relies on schematic diagrams, and a fourth gives no figures at all in most parts of his section. The text is sound and up to date, and the authors have made full use of the monographs which they list in the bibliography, arranged under species. The animals chosen are usually representative, though one wonders at the inclusion of some and the absence of others. In Great Britain, for example, *Amœba*, *Hydra*, *Lumbricus* and *Astacus* would be treated in a more elementary book, but, on the other hand, a Tectibranch, a Pulmonate and a Crinoid would be dealt with among the types selected here.

The section on the Protozoa is excellent and gives many cultural and experimental hints. The sponge section is rather meagre, and one feels that an opportunity has been missed of stressing familial and generic characters. It is true that *Cliona*, *Halichondria*, *Chalina* and *Microciona* are all monaxonids, but the first three belong to families developing monaxon megascleres only, *Microciona* to a family characterized also by the presence of microscleres. Yet this is not mentioned, and no indication is given in Figs. 50–55 that there is any difference in size or function between the large skeletal spicules and the minute scattered microscleres of the soft tissues of the sponge; nor is it suggested that a hand section would illustrate the arrangement of these two kinds of spicules.

The parasitic worms have been adequately dealt with, and for this many will be grateful, because the information regarding them is too often to be found only in the medical and veterinary literature. The name of the phylum Aschelminthes, to include Rotifers, Gastrotricha and Nematoda, is new to European zoologists.

The Annelid and Arthropod sections are good, and it is helpful to have figures of the compound Ascidian and its larva. Very few errors were noted. That bugbear of the American zoologist, the plural of a Latin term, turns up again (scolex–scoleces, *sic*). In

Fig. 164, of the medicinal leech, the apical lobe of the nephridium has been wrongly labelled "nephrostome". Will the author please look up M. L. Bhatia's paper (*Quart. J. Micr. Sci.*, 81, 1; 1938).

A well-balanced and very useful treatise on little-known species has resulted from the work of the team. This may be largely due to the training of the majority at the great Marine Biological Station at Woods Hole, Mass. The printing and production are of high class. So, unfortunately, is the price.

N. B. E.

RACE FORMATION IN MAN

Races

A Study of the Problems of Race Formation in Man. By Dr. Carleton S. Coon, Dr. Stanley M. Garn and Dr. Joseph B. Birdsell. Pp. xiv+153. (Springfield, Ill.: Charles C. Thomas; Oxford: Blackwell Scientific Publications, Ltd., 1950.) 21*s.* 6*d.* net.

THIS work defines a race as a somatically unique population or collection of identical populations. The blend of Mongoloid, European White and Polynesian with diffuse Negroid elements in the Hawaiian Islands is considered a race in the meaning of the term proposed, and twenty-nine other populations are distinguished as being probably unique in the same sense.

In discussion of the topic of the character of the skull in man, it is noticed that early man, as represented by archæological finds, was thick in the skull as compared with modern man. Roundheadedness is said to be late Pleistocene in development, common to-day, linked to nothing else in particular and of no discernible functional advantage, but the most extensively measured of all physical criteria. Nevertheless, in connexion with some other physical characteristics, a suggestion is made that genetic variations serve, in the long run, to suit races to different environments. For example, around the Arctic Circle we find uniformly short people, and the authors suggest that selection has favoured those who can store and utilize fat, and escape freezing at their extremities in that climate. The fatty eye-shield of the Mongoloid eye is stated to be a guard against the danger of freezing of the eyes in polar climates. In matters of pigmentation of the eye, the discussion is possibly not equally convincing. Eyes in which there is little pigment in the front of the iris are numerically predominant only in northern Europe, at least in their origins. The authors correlate this distribution with the relatively weak intensity of light in temperate climates. They state that dark-eyed people do not 'see better' than light-eyed, but that they resolve images better under conditions of intense illumination. The authority under which this statement is made is not apparent from the text, and personally I cannot estimate its value. The authors say that they do not know any conditions under which a blue eye is better than a brown one.

In controversy, at one point the authors state that one might suppose students of human behaviour would have been interested in relating varieties of behaviour to anatomical, physiological and genetical variations in man. But, as a matter of fact, very few of the findings of the social scientists lend themselves to scientific treatment with the precision which may be accorded the physical aspects of race. The disinterest mentioned might, I suggest, be ascribed to the intervention of psychology, since psychologists are interested in such matters as abilities to resolve images under conditions of bright light. If brown eyes make better marksmen in tropical areas, the army might also be interested.

However, if writers on the subject of the physical aspects of race fall into such deficiencies in precision as they sometimes attribute with some justice to social scientists, then one may recall the fact that Darwin was prompted to formulate his concepts of biological adaptation as a result of reading an essay by Malthus on the "Principle of Population", which contained an element of imprecision. Social scientists are interested in problems in subjects such as politics, religion, art or history, in which the isolation of individual abilities for study is still of interest, but in which the field itself is collective. I agree that a problem of relationship between varieties of behaviour and genetical variation may be said to be outstanding. However, capacities for learned behaviour in man may be widespread and independent of racial constitution as a general rule. R. F. FORTUNE

ATOMIC PHYSICS FOR THE NON-SPECIALIST

Atomic Physics

By Dr. Wolfgang Finkelnburg. Translated from the revised German edition in co-operation with the Author by George E. Brown. (International Series in Pure and Applied Physics.) Pp. x+498. (London: McGraw-Hill Publishing Co., Ltd., 1950.) 55*s.* 6*d.*

THE subject material of this book covers a wider field than one expects from the title. In addition to those subjects usually associated with atomic physics, the author devotes nearly half his book to nuclear, molecular and solid-state physics. It is not, however, suitable as a text-book for these subjects, the author having chosen to discuss briefly a very wide range of material, with a consequent loss of depth in the treatment of any particular subject. It is intended more as general reading for senior and graduate students of physics, engineering and chemistry, to give them an appreciation of recent developments in fields other than those in which they have acquired some specialist knowledge. Considered from this point of view, it is a good book.

The book has been written with the minimum of experimental detail and theory required to provide some factual basis for discussion, the ease of reading achieved in this way being somewhat offset by rapid changes of subject and the frequent introduction of new ideas. Many recent advances in the various fields are mentioned, including some hypotheses in the current literature which are still in dispute. It is somewhat surprising at first to find subjects such as Heisenberg's theory of multiple meson production presented in much the same way as the experiments of Rutherford on alpha-particle scattering. A successful attempt has been made to emphasize the recent advances in each subject and to indicate the present frontier of knowledge. There is also an emphasis on the inter-relationship of the concepts and basic knowledge required for an understanding of this large field of scientific knowledge.

The text is well illustrated with figures, diagrams and photographic reproductions. On the whole they have been well chosen; for example, the description of instruments of nuclear physics includes photo-

graphs or drawings of a cloud chamber, Geiger counter, electrostatic generator, linear accelerator, cyclotron, synchrotron, betatron and bevatron, all in the space of eighteen pages. There are a number of misprints and errors, which were particularly noticeable near the beginning of the book, some sixteen having been counted in the first one hundred pages. In a description (p. 65) of an experiment to demonstrate the corpuscular nature of light, the sense of the experiment is lost, and criticism of the Fermi theory of beta-decay (p. 281) is misdirected. On p. 284 it is stated that "The first induced transformation of this kind was discovered in 1919, though by no means intentionally, by Rutherford when he bombarded pure nitrogen with alpha particles".

Scientific lapses of the kind mentioned above are, however, very infrequent, and a high standard of scientific exposition and clarity is maintained. This would seem a useful book to have available in science libraries.

A. G. Ward

TRACER TECHNIQUE

Radioactive Tracer Techniques

By Prof. Geo. K. Schweitzer and Ira B. Whitney. Pp. vi+241. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1949.) 16*s*. net.

Introduction to Radiochemistry

By Gerhart Friedlander and Prof. Joseph W. Kennedy. Pp. xiii+412. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 40*s*. net.

Isotopic Tracers and Nuclear Radiations

With Applications to Biology and Medicine. By William E. Siri. Pp. xiii+653. (New York and London: McGraw-Hill Book Co., Inc., 1949.) 106*s*. 6*d*.

THE use of isotopes as 'indicators', or 'tracers', in all sorts of scientific and technical problems is by now widespread. Its adoption by still more laboratories is quite often hampered by the lack of trained workers; but instruction courses in various centres try to provide the necessary number of experts, and a further essential help is given by several books recently published. Since the kind and degree of training needed varies from place to place, it is gratifying to see that authors try to cater for this diversity of needs. The three books under review are examples of this variety.

The manual on "Radioactive Tracer Techniques", by Prof. G. K. Schweitzer and I. B. Whitney, is meant for beginners, and considers almost exclusively the practical side. True to the sound principle of 'safety first', it is very emphatic in impressing on its readers in Chapter 1 the necessity to take precautions for the protection of health and the avoidance of contamination. Detailed descriptions follow for the best lay-out of a radiochemical laboratory of moderate size, with recommendations of suitable material for floors and walls. Further chapters deal with chemical, physical and biological experiments and the tracer solutions required for them; the added list of commercial organizations supplying equipment and radioactive material quite naturally takes into consideration only the American market. A small table of nuclides "of tracer interest" is also provided; the modest size of the book does not allow for inclusion of more than the most common tracers, but the beginner will be thankful for these limitations.

G. Friedlander and Prof. J. W. Kennedy's "Introduction to Radiochemistry" goes considerably deeper into the matter. Its aim is to give the reader first of all the theoretical knowledge necessary for those who want to make the best use of the possibilities offered by the tracer technique. In spite of its title, it devotes several chapters to subjects usually considered as belonging not to radiochemistry but to the domain of physics, like nuclear structure and nuclear reactions, sources of bombarding particles, and measuring instruments. The matter is presented in a very clear, concise and competent way, reflecting the great experience gained by the authors in the instruction courses they have conducted for many years. As a special merit of the book may be mentioned the excellent chapters on "Statistical Considerations in Radioactivity Measurements", "Identification, Concentration, and Isolation of Radioactive Species", and "Chemistry of Low Concentrations".

An appendix contains, on more than ninety pages, a table of the radioactive and stable isotopes of all the elements up to curium, and a table of cross-sections for neutron activation. At the end of each chapter there is a collection of exercises for the student (mainly calculations) and a list of references. The book will be found most useful by all who have to conduct, or attend, courses in radiochemistry, and also by many research workers.

W. E. Siri's stately volume on "Isotopic Tracers and Nuclear Radiations" is too voluminous to form the basis of an instruction course for students, but will prove of the greatest value to research workers on biological and other subjects. Although the author modestly states that it was his intention to compile "some of the material that appears to be most essential to applications of isotopic tracers and nuclear reactions", with the help of a number of contributing authors he has produced a handbook so rich in information that frequently it will save the trouble of looking up the widely scattered original literature. (Only one small misprint has been noted: on p. 537 instead of RaB read RaC, and instead of RaC read RaC′.) The book consists of three parts, "Isotopes and Nuclear Radiations", "Methods and Instruments" and "Biological and Medical Applications of Isotopes", this last part being contributed entirely by Dr. E. C. Dougherty. It is characteristic of this book that—in contrast with the two treatises mentioned before—inactive isotopes and their uses receive as much attention as the radioactive ones; in the second part we find accordingly a chapter of some thirty pages describing the various types of mass spectrographs. Compared with the attention given to these and other physical apparatus and methods (counters, cyclotrons, betatrons, synchrotrons, etc.), the space devoted to chemical techniques is not great; as a matter of fact, Friedlander and Kennedy's book is in this respect much more informative. One of the most valuable features of Siri's handbook is the wealth of tables, diagrams and references to the literature; in addition to the lists given at the end of each chapter, there is an extensive bibliography in which the papers are arranged according to the radioactive or inactive nuclides employed as tracers. These few remarks must suffice to indicate the contents of an outstanding book, too comprehensive to be described in detail.

F. A. Paneth

An Index of Tumor Chemotherapy

By Helen M. Dyer. (Federal Security Agency: Public Health Service.) Pp. 329. (Washington, D.C.: Government Printing Office, 1950.)

SOME ten years ago Dr. J. C. Hartwell, of the United States National Cancer Institute, published a survey of compounds which have been tested for carcinogenic activity. This survey has been extremely useful to cancer research workers, and in my opinion has been directly responsible for the great advances in the theory of carcinogenesis which have taken place during the past decade. It is to be hoped that Dr. Hartwell will be able to prepare a new edition of his work.

Lately, Dr. Helen M. Dyer, a biochemist of the National Cancer Institute, has prepared an index of tumour chemotherapy. This volume, which must have involved a great deal of work, is described as a tabulated compilation of data from the literature on clinical and experimental investigations. There are more than five thousand entries and more than two thousand three hundred references. The value of work in this field is often difficult to assess. Results obtained at one time under carefully controlled conditions sometimes cannot be repeated, presumably because the tumours or the animals have changed. The compilation shows up some of the apparent discrepancies of this type. Thus, for example, many workers have observed inhibition of growth of tumours in animals and patients treated with insulin but even more have reported negative results with insulin treatment.

On the title page is a quotation from Cicero: "If no use is made of the labors of past ages, the world must remain always in the infancy of knowledge". This survey helps enormously in the use of old work, first in making it easy to find out whether a substance has been tested for its effect on cancer, and secondly by indicating which types of substances have some activity, suggesting possible lines for future work. Dr. Dyer is to be thanked for the service she has rendered to cancer research. E. BOYLAND

College Chemistry

An Introductory Textbook of General Chemistry. By Prof. Linus Pauling. Pp. x+705. (San Francisco: W. H. Freeman and Co., 1950.) 4.50 dollars.

PROF. L. PAULING's new book is a simplified version of his well-known "General Chemistry", published three years ago. A more gradual approach to more difficult subjects is used, and a new chapter on biochemistry, with a discussion of colour photography and some other new features, have been introduced. As in the older book, special emphasis is laid on atomic and molecular structure, this aspect being introduced quite early in the course, although general descriptive chemistry is well presented in a logical form in relation to general principles. The historical aspect is much used, and the book is profusely illustrated. The treatment is modern, and the emphasis is rather on the structural side. The physical chemistry is introduced in sections sufficiently self-contained to make them really informative and coherent.

The book contains what is really a comprehensive course, and although it is intended for first-year American students it may be found rather difficult, in spite of the great care which has been taken to make clear what is presented. The order of treatment is not very different from that in other modern books; although some of the chapters in the middle of the book are the most difficult, they should not be beyond the capacity of elementary students in the form in which they are written.

This is an interesting and thoughtful book, and teachers and more advanced students will find much in it which they will read with pleasure and profit. The printing, paper and illustration are of very high standard.

Organic Syntheses

An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Vol. 29. Cliff S. Hamilton, Editor-in-Chief. Pp. vi+119. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 20*s*. net.

ONE of the most interesting of the thirty-four items contained in this volume is a precise account of the preparation of the Raney nickel catalysts *W*-6, *W*-7 and *W*-5, possessing high contents of aluminium and adsorbed hydrogen. These are particularly effective for hydrogenations under low pressures, catalyst *W*-6 being advocated for the hydrogenation of alkyne and alkene linkages, and of aldehydes, ketones, oximes, nitriles, nitro-compounds, and benzenoid and pyridinoid nuclei. Among the wide range of useful syntheses, those of 1-ethynyl*cyclo*hexanol and 1-acetyl*cyclo*hexene are of particular interest in that they illustrate the growing application of acetylene as a synthetic agent. The first of these substances may be obtained in yields reaching 75 per cent by the interaction in liquid ammonia of dry acetylene, sodium and *cyclo*hexanone, and subsequent acidification. When heated in benzene with phosphorus pentachloride, this substance isomerizes to 1-acetyl*cyclo*hexene, obtainable in yields up to 88 per cent. These simple and effective processes are tantamount to the addition in two ways of one molecule of acetylene to one of *cyclo*hexanone.

This volume maintains the high standard of its predecessors. There is a cumulative index covering Vols. 20–29. An accompanying leaflet directs attention to the danger of recrystallizing benzoyl peroxide from hot chloroform; it may be purified safely by adding methanol to its solution in chloroform at room temperature. JOHN READ

The Physical Basis of Mind

A Series of Broadcast Talks. Edited by Peter Laslett. Pp. viii+79. (Oxford: Basil Blackwell, 1950.) 5*s*. net.

THE introductory talk in this series of broadcasts was given by Sir Charles Sherrington; then followed Profs. E. D. Adrian, W. E. Le Gros Clark, S. Zuckerman, Drs. E. T. O. Slater, W. R. Brain and Prof. W. G. Penfield, in that order; all speaking as men of science, as specialists in the anatomy, physiology and pathology of the brain, or as students of psychology and psychiatry. In the last broadcast three philosophers contributed short discussions. Prof. Adrian and the five speakers who followed him each took up one topic and dealt with it clearly, succinctly and without unnecessary jargon. These talks were excellent to listen to and definitely informative. Read together in a book they are not quite so good, since the reader perceives gaps between the various items which the listener would not notice. Even so, they provide a useful summary of present-day knowledge.

Apart from a brief warning by Prof. Zuckerman, the scientific speakers all dealt with their subject in terms of the ordinary 'common sense' view that

body and mind are distinct but interacting substances. This Cartesian view leads to difficulties and is not the only possible one. The philosophers' task should be to discuss these difficulties and explain about the alternatives and their difficulties. The speakers only did this in part. Lord Samuel, who spoke first, pointed out that the attractive short cuts out of the difficulties of the Cartesian theory, by denying the reality of either body or mind, will not work; but after that he seemed content with Cartesian dualism. Prof. A. J. Ayer was obviously thinking in terms of some different theory but never explained what it was. Prof. G. Ryle, who spoke last, dealt very shrewd blows at the Cartesian theory, but spoke in parables and suggested no alternative. Of course, they each had very little time allowed to them and did not do much collaboration.

The last word undoubtedly rests with Sir Charles Sherrington: "Aristotle, 2,000 years ago, was asking how is the mind attached to the body. We are asking that question still." A. D. Ritchie

Goethe—Wisdom and Experience

Selections by Ludwig Curtius. Translated and edited, with an Introduction, by Prof. Hermann J. Weigand. Pp. 300. (London: Routledge and Kegan Paul, Ltd., 1949.) 16*s*. net.

TO men of science, Goethe is, or should be, always interesting. An anthology, limited to his prose, is welcome, both as showing the range of his mind, and—wholesome, if sometimes a little irritating—as manifesting his contempt for specialization and all its works. It may be no mere accident that the race that produced him produced also the founders of the *Gestalt* theory. For Goethe, there must be 'wholes' or nothing. Couple this tenet with exceptional powers of observation, and the result is a philosopher, passionately fond of Nature, but blindly intolerant of mathematics. We are then able to enjoy this collection of extracts as they deserve to be enjoyed, sweeping majestically over philosophy, science, art (and much else besides), with a kind of searchlight, by no means corrected for chromatic aberration, yet intensely revealing.

In reading the introduction contributed by Prof. H. J. Weigand, it is perhaps well to recollect that Goethe set great store by his scientific achievements. Odd as this attitude may seem to us, ready to acclaim his poetic gifts, it was so ingrained as largely to condition much of his life. With all this in mind, pleasure and profit await the reading of this book.

F. I. G. Rawlins

Analysis and Design of Experiments

Analysis of Variance and Analysis of Variance Designs. By Prof. H. B. Mann. (Dover Series in Mathematics and Physics.) Pp. x+195. (New York: Dover Publications, Inc., 1949.) 2.95 dollars.

THOSE engaged in the teaching of experimental design have for some time felt the need of a book on the theoretical aspects of the subject. This work satisfies that need, and, read in conjunction with a treatise of a more practical nature, it should provide an excellent survey of contemporary experimental design.

Introductory chapters on the χ^2 distribution, matrices and the analysis of variance for a one-way classification are followed by three chapters devoted to the derivation of the F-test as a likelihood ratio test of a linear hypothesis, the analysis of variance of a general r-way classification, and a discussion of the power function of the F-test. The general methods are then applied to the principal types of design now in use. In addition to the discussion of methods of analysis, there are excellent sections on the construction of Galois fields, hyper-Græco-Latin squares, balanced incomplete block configurations and confounded factorial designs. Tables of F and of the power function of the F-test are provided.

It is possible to regret certain omissions, notably those of fractional replication and of partially balanced incomplete block designs. The nature of the subject is such that a certain amount of cumbersome algebra is unavoidable in the discussion of the general theory, but a greater use of matrix and vector methods to simplify some of the arguments would not have been out of place in a book of this type, which is unlikely to appeal to a reader without a mathematical background. M. R. Sampford

First Year Applied Mathematics

By Norman Cannell. Pp. 284. (London: University of London Press, Ltd., 1949.) 10*s*. 6*d*. net.

THE general plan underlying this book is, according to the introduction, "that the teacher should concern himself with systematizing common knowledge and experience and encouraging the pupil to work a variety of examples rather than with an exhaustive treatment of fundamental concepts".

This is admirable so long as a proper balance is preserved between the two. It appears to the reviewer, however, that in this book far too much stress is laid on examples, of which there are more than 1,500 in about 250 pages of text, and much too little on the fundamentals. The book is a first reading of applied mathematics to provide a minimum course for candidates offering the subject at the Advanced level for the General Certificate of Education; surely at this stage fundamentals are rather important if a student is really to 'know' his subject. One feels that the book would be more satisfying if less space had been devoted to questions and more to experimental work; perhaps the author would consider this point for a future issue.

Not everyone will agree with the arrangement of topics in the book, though the author says this is designed chiefly for convenience in teaching. The worked exercises are well thought out, and a good feature is the frequent use of the 3–4–5 and the 30°, 60°, 90° triangles in the problems.

Agricultural Science in the Sudan

A Bibliography with Abstracts. By Dr. R. L. Knight and Dr. B. M. Boyns. Pp. 256. (Arbroath: T. Buncle and Co., 1950.) n.p.

ABDALLA BEY KHALIL, Minister of Agriculture, notes in a foreword to this useful compilation that expanding social, educational and medical services in the Anglo-Egyptian Sudan have been made possible only by the development of agriculture. In that development scientific research has played a part. Some nine hundred scientific papers, most of which were written in the Sudan, are reviewed in this book; there is a good index; and the period covered extends up to 1948. In many cases, author's summaries are quoted, and in many others careful abstracts have been prepared. These are particularly valuable where the original paper is not easily accessible. The book is intended to serve as a sort of pocket library for agricultural research workers; it is also a contribution to the history of a successful experiment in administration.

THE ALKALI INDUSTRY OF GREAT BRITAIN: CENTENARY OF A CHEMICAL COMMUNITY

THERE has appeared recently a historical account of the "Chemical Industry in Widnes"*, a book of singular attraction to any interested in the fluctuating fortunes of the Leblanc soda-ash process; or in the development of any large and interwoven group of chemical industries through a long sequence of changing years and circumstances; or, indeed, in the wider aspects of the influence upon a district, originally purely agricultural, of more than a hundred years of development of fundamentally important and massive chemical manufactures at its centre. Such is the history of Widnes, and by good fortune a man of diverse qualities was at hand to write it: for the author, Dr. D. W. F. Hardie, a member of the Widnes Research Laboratory of Imperial Chemical Industries, Ltd., General Chemicals Division, is not without distinction as a man of letters and a novelist. Moreover, he has obviously been inspired by the theme of the chemical industry of Widnes to prosecute careful and extensive research into the details of its history, so that union in one person of a conscientious historian, a scientific outlook, and unusual literary ability has produced a record which is both authentic and captivating.

Widnes, little more than a hundred years ago, was a hamlet on the north bank of the River Mersey. Between it and Liverpool, some twelve miles to the north-west, stretches an area of mainly flat country with alluvial soil well adapted to arable and pasture farming and to market gardening. Opposite Widnes the River Weaver enters the Mersey after a circuitous course past Winsford and Northwich (centres of the Cheshire salt mines) around the sandstone hills and bluffs which lie between the salt beds and the Mersey, and which stand in contrast to the uniformly flat country of south Lancashire on the other side of the Mersey. Thus in the late eighteenth and early nineteenth centuries, Widnes and its surrounding district were at the centre of a purely agricultural area, the nearest towns of any size being the port of Liverpool to the west; to the east, the town of Warrington, where the main road from the south to Carlisle crosses the Mersey; and, to the north, the township of St. Helens, which became industrialized somewhat earlier than Widnes.

Dr. Hardie states that the early attempts to manufacture soda from salt were sited in Liverpool, but that it was soon realized that the complexity of the Leblanc process demanded more space than was conveniently available in an already developed mercantile town and port. In particular, the quantities of sulphuric acid needed for the first stage of the process—the conversion of salt into 'salt cake' (acid sodium sulphate)—necessitated the manufacture of vitriol by the chamber process on a very large scale. So it came about that first John Hutchinson in 1847, and some years later James Muspratt, set up independent works at Widnes to produce alkali, sulphuric acid and, as time went on, other 'heavy' chemicals; while similar factories were also commenced in the neighbourhood by others. Widnes came to be selected, no doubt, not only because of available space but also because its situation opposite the confluence of the Weaver with the Mersey was singularly convenient for delivery by water transport of the primary raw material needed for alkali manufacture—salt from Northwich and Winsford.

There is no need here to dwell upon the many outstanding figures in chemical industry who were intimately connected with Widnes during the latter half of the nineteenth century—Muspratt, Gossage, Gaskell, Deacon, Hurter, Henry and John Brunner and the rest: Dr. Hardie has given a complete picture of all these and of their individual contributions to the building of a great industry. He has also gone deeper into personal aspects, showing how in numerous instances the foremen and workmen of the old independent firms maintained contact with them, not only themselves, but often in their sons and grandsons; so that, as the late Sir Frederick Bain says in his foreword to Hardie's book, Widnes "can still hear the talk of its fathers, grandfathers and greatgrandfathers" and "possesses at this time the great treasure of continuity". Hence, although the old independent alkali firms of Widnes merged in 1890 into the United Alkali Company to fight for survival against the ammonia-soda and electrolytic alkali processes, and all these eventually in 1926 became part of Imperial Chemical Industries, Ltd., there are still many descendants of the workers in the original constituent firms of the United Alkali Company occupied in the manufacturing plants of its present-day counterpart, the General Chemicals Division of Imperial Chemical Industries, Ltd. There has thus arisen at Widnes, side by side with the agricultural community which still exists as formerly outside the town itself, a distinctively chemical community derived, it is true, to some degree from the local agricultural families, but doubtless to a much greater extent from beyond the area.

The manner in which, in many instances, successive generations of workers have elected to follow employment in the same concerns as their forbears, although of course not peculiar to the Widnes chemical industry, is nevertheless an asset of definite value to any commercial undertaking. At Widnes, it perhaps had its roots in the original circumstances of a number of completely individual firms, each of relatively small size by present-day standards. It seems doubtful whether such continuity, or rather the motives underlying such continuity, may be expected to be seen in the employees of the vast modern undertakings, in which contact between the higher levels of management and direction and the foremen, charge-hands and process workers is bound to be so much less personal and direct. Perhaps, unless great care is taken to conserve this element of personal interest, modern developments will result in the loss of a Victorian relationship between good employers and good employees—a loss not wholly to be compensated by the advantages gained for the workers of the twentieth century in other ways.

However this may be, there is another aspect of the developments at Widnes (and elsewhere) in the mid-nineteenth century which was not so admirable,

* A History of the Chemical Industry in Widnes. By Dr. D. W. F. Hardie. Pp. xii + 250 + 38 plates. (Liverpool: Imperial Chemical Industries, Ltd., General Chemicals Division, 1950.) 21s.

and which provides an example to be avoided. By-products of the chemical processes in use, notably hydrochloric acid from the salt-cake process and sulphur compounds both from the manufacture of sulphuric acid and, especially, from the waste from the black-ash alkali process, were at first allowed to escape into the atmosphere in undesirable quantities, with serious consequences to vegetation within a considerable radius of the works. In the earlier years of development the wastefulness of inefficient recovery of such by-products, most of which possessed commercial value, seems not to have been sufficiently considered: but the economic consequences were two-fold. Not merely was the loss of chemical products to a large extent unnecessary and uneconomic; but also the damage caused to the adjacent agricultural lands was even more serious. The alkali manufacturers themselves soon realized the position and, moved alike by their own interests and those of the neighbouring agricultural community, worked out procedures to minimize the troubles and also, as Dr. Hardie points out, gave their fullest assistance to the inquiry of a Select Committee set up by the House of Lords in 1862 to consider the matter. In 1863, and again in 1875, Alkali Acts were passed to control the amounts of noxious gases permitted to escape to the atmosphere from chemical processes, and 'alkali inspectors' were appointed to see that the provisions of the Act were enforced. Dr. Hardie records that "the Alkali Act of 1863 imposed no burden on the alkali manufacturers", since the latter already had equipment in operation to safeguard the position: "all that the Act did impose was a stricter supervision of operating conditions". On the other hand, in his foreword Sir Frederick Bain says, "There is no burking the truth about the conditions of work in the early days, of the wastefulness and misuse of valuable materials. Today we must think these conditions dreadful; but we must remember also that it was the constant urge to improve those conditions, the increasing pursuit of new knowledge to overcome them, that made possible the modern scientifically controlled chemical industry".

A further unfortunate consequence, not peculiar to the Widnes district or indeed to purely chemical industries, was the inefficient combustion of fuel in steam-raising, etc., which has caused so much pollution of the atmosphere near industrial centres with smoke, soot and mineral ash. This also is gradually passing away, indeed has almost passed away as far as the modern large chemical manufacturing firms are concerned: for again, desire not to cause a nuisance and the need for the most efficient use of increasingly costly fuel work towards the same end. Nevertheless, as is well known, smoke pollution has been much more persistent than the chemical pollution of the atmosphere. Chemical pollution became negligible, except in isolated instances, by about 1880 or a little later; but even forty years ago, Widnes, for example, was hidden from view even on a bright day by a smoke pall. To-day, in similar conditions, a slight haze may be seen from a distance to cover the town, but the old black smoke veil has gone, we may hope, for ever.

Such is the story of Widnes. A locality perhaps (like other relatively flat regions of the English countryside) not markedly picturesque or beautiful, but a useful and profitable area for farming: an agricultural community seriously menaced at one time by pollution of vegetation by chemicals and by smoke; a rapidly developing chemical community responsible for the production of much of the heavy chemicals (alkalis, acids and others) needed in many British and foreign industries; and at last both agricultural and chemical interests able to operate in contiguity and without undue interference. In modern times, great chemical factories are developed in areas previously mainly agricultural without 'teething troubles' of the kinds which Widnes had to endure. The chemical processes are evolved in the laboratories and pilot plants of large organizations, often far distant from the site of the future factory. There is a minimum of dislocation and inconvenience to the adjacent countryside and its inhabitants, once the travail of construction and building contractors is at an end. From the point of view of general commercial prosperity it ought, indeed, in general to be advantageous to have a manufacturing unit set within a purely agricultural area, and this in the long run has happened in Widnes.

There remains the more impalpable but important matter of continuity in personal human relationships between employer and labourer, familiar in the farming industry, exemplified also in the chemical industry of Widnes in the past hundred years, but by no means invariably present in manufacturing industries. It is an important matter, even merely as one of good economics, and it is too valuable to be overlooked, as Dr. Hardie's book abundantly shows. Can it be preserved in the altered conditions of process-development in perhaps distant research and development centres, and direction and management at the higher levels also remote from the actual production centre? Let us hope so, for, as Sir Frederick Bain wrote, "This is the great fortune of Widnes".

T. P. Hilditch

NUCLEAR DIVISION IN AMŒBÆ AND ITS BEARING ON CLASSIFICATION

By Dr. B. N. SINGH

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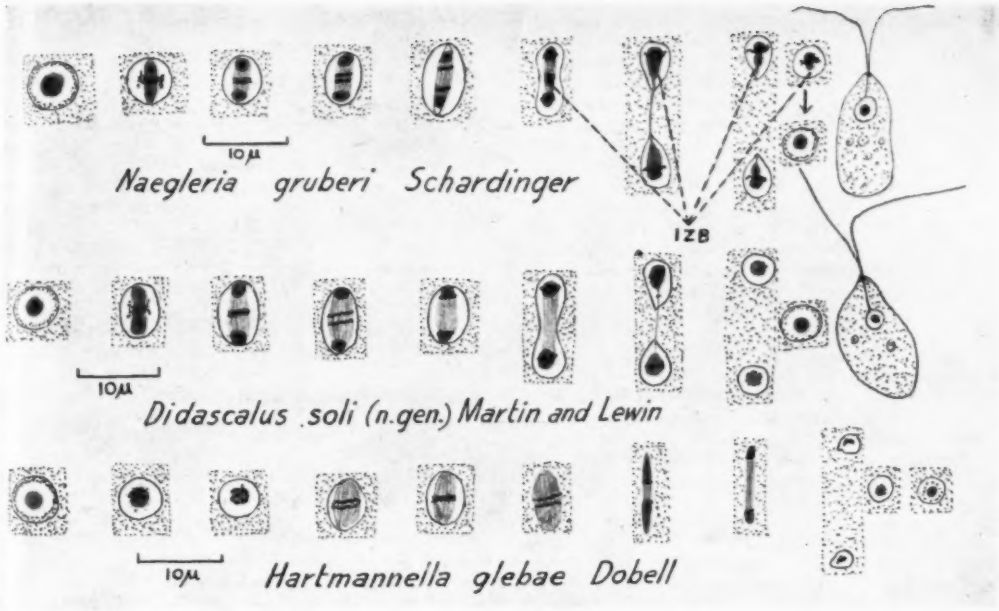
In the past, the order Amœbida Calkins has been divided into families on such characters as the presence of a flagellate stage under certain physiological conditions, their parasitic or free-living nature, the possession of an accessory body called *Nebenkörper*, etc. Such a system is not based on any reasonable theory of the evolution of the group of organisms called amœbæ.

The genera and species among the families of Amœbida have been created by earlier workers largely on the nuclear structure and the mode of nuclear division. A number of memoirs dealing with this subject have appeared since the work of Vahlkampf[1]. A careful study of these memoirs shows that conflicting views have been put forward by different workers who carried out cytological investigations. The karyosome, which should be called 'nucleolus' because it is Feulgen-negative, has been supposed to give rise partly or completely to chromosomal chromatin in some forms and not in others. The 'peripheral chromatin' has been stated to be completely absent in some amœbæ and present



in others. Claims have been made that 'peripheral chromatin' sometimes gives rise to chromosomes and sometimes disappears completely during division. This confusion can be assigned to two principal reasons: first, the amœbæ have been grown in rich nutrient media with uncontrolled bacterial food, leading to the production of abnormal forms; and secondly, cytological techniques have been used which are not specific for the location of chromosomal chromatin. Before the Feulgen technique came into use, it was impossible to locate true chromatin through all the stages of division. Sole reliance on iron-alum hæmatoxylin has led Gläser[2], Dobell[3] and others to put forward the theory of the fragmentation of the nucleolus (karyosome) to give rise to chromosomal chromatin in some amœbæ. This theory has in the past had great influence on many protozoologists and has created much confusion in the study of the nuclear cytology of free-living and parasitic amœbæ. The mode of nuclear division in *Entamœba histolytica* and other intestinal amœbæ is still by no means clear.

Difficulty in obtaining enough material in various stages of normal nuclear division has contributed further to the wrong interpretation of division, with resulting confusion. A satisfactory classification of amœbæ remains to be found.

Work on the selectivity in bacterial food by soil amœbæ and other groups of micro-predators for many years has resulted in the development of a culture method[4] for growing small free-living amœbæ for the study of their nuclear division. By this method a large number of normal, young and actively dividing amœbæ can be obtained on a single slide, confined to a small area, so that it is easy with an oil-immersion objective to find individuals in various stages of division.

A study of thirteen strains, comprising nine distinct species, of small free-living amœbæ has been made under standardized and reproducible cultural conditions with a suitable bacterial food supply. The use of Feulgen's reaction and counterstaining with light green has shown that in all the species the resting nucleus contains a Feulgen-negative nucleolus (karyosome) and Feulgen-positive chromatin granules. The amœbæ fall into two main groups according to the mode of nuclear division. In the first group, the nucleolus divides into two equal halves to give rise to the 'polar-masses' as shown in the accompanying drawings for *Didascalus soli*. In the second group of amœbæ, the nucleolus disappears, as in *Hartmannella glebæ*. In both groups the pre-existing chromatin granules give rise to chromosomes, and at the end of nuclear division the mass of fused Feulgen-positive chromosomes fragments into granules and occupies the position as seen in a resting nucleus (see drawing). The work of Kudo[5] and Liesche[6] demonstrates in *P. carolinensis* and *A. proteus* that Feulgen-positive chromatin gives rise to chromosomes during division, as I have found in *Hartmannella glebæ* and three other species belonging to this genus. The studies of Zuelzer[7], Volkonsky[8], Rafalko[9] and others in amœbæ also show that Feulgen-positive chromatin gives rise to chromosomes during mitosis. In this respect the type of mitosis found in amœbæ is similar to that found in higher animals and plants. There is no justification for writers of elementary text-books on biology showing an amœba happily dividing by amitosis or in some such primitive way, as was thought nearly a hundred years ago.

The first group of amœbæ in which the nucleolus persists may be further subdivided according to whether Feulgen-negative material collects between the chromosomal plates at anaphase to form an 'interzonal body' (*IZB*), as occurs in *Nægleria gruberi*. This structure has recently been clearly described by Rafalko[9].

One of the chief functions of the nucleolus seems to be the formation of the spindle in all the nine species studied. The resting nuclei of some of the large species of free-living amœbæ, such as *Amœba proteus*, *Pelomyxa carolinensis* and others, seem to be

structurally similar, though they contain several nucleoli instead of a single nucleolus (karyosome). Kudo[5] has clearly shown the origin of the spindle from the nucleoli in *P. carolinensis* Wilson.

The two distinct types of nuclear division seem to provide a logical basis for a rational classification of amœbæ into two families: Schizopyrenidæ and Hartmannellidæ. Such a system of classification also throws light on the evolution of amœbæ, as has been observed in the study of the nine species of free-living amœbæ. A form like *Naegleria gruberi* has during nuclear division 'polar masses' and 'interzonal bodies', and can readily produce a temporary flagellate stage under certain physiological conditions. It may be considered a primitive form. In the course of evolution it appears that amœbæ lose the power of producing 'interzonal bodies', although the ability to form a temporary flagellate stage is retained. *Didascalus soli* n.gen. has been found to produce temporary flagella with difficulty and does not possess 'interzonal bodies' during nuclear division (see drawing). Another amœba, *Schizopyrenus russelli* n.gen., n.sp., has been found not to produce a temporary flagellate stage. The nuclear division of this amœba is indistinguishable from *Didascalus soli*, as are the active forms, although the two species can be readily distinguished by the characters of their cysts and the process of excystment. It seems that *S. russelli* and two other species (*S. erythænusa* n.sp. and *S. atopus* n.sp.) have lost the primitive character of temporary flagella production, but retain the family character in having 'polar masses' during division. When we come to the more advanced family Hartmannellidæ, the nucleolus (karyosome) or the nucleoli disappear during division and a spindle with chromosomes arranged as an equatorial plate is formed, as happens in higher plants and animals. This type of division has been studied in four species of amœbæ (*Hartmannella glebæ*, *H. rhysodes* n.sp., *H. leptocinemus* n.sp. and *H. agricola*). The characters of the formation of 'polar masses' during nuclear division and the power to produce temporary flagella under certain conditions are completely lost in this family.

The creation of certain genera and of species which can be readily identified by anyone having a little protozoological training will, however, ultimately depend on careful study of the morphology and other characters of amœbæ under standardized and reproducible cultural conditions. Characters such as the form and size of active amœbæ under identical cultural conditions, the presence or absence of well-defined ectoplasm and endoplasm, the method of movement of amœbæ, character of cysts, the method of excystment, the division of nuclei inside the cysts, and the type of spindle produced during division, etc., will prove very helpful in identifying amœbæ. Nuclear structure and the mode of nuclear division, although essential in creating families and certain genera, will not solve the problem of the more detailed classification of amœbæ.

The work summarized above will shortly be published more fully elsewhere.

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CENTENARY CELEBRATIONS OF THE GEOLOGICAL SURVEY OF INDIA

A BRIEF account of the history of the Geological Survey of India has been given in *Nature* of January 6, p. 10, showing that the formation of this Survey as a continuous department dates from the arrival in India of Thomas Oldham on March 5, 1851. The centenary of this event was celebrated in India last January. Funds for expenditure thereon were provided partly by the Government of India and partly by private subscription by mining companies and others. Many foreign Governments were invited to send delegates, and some twenty came from overseas, representing Great Britain, the United States, Canada, Australia, Southern Rhodesia, Holland, Germany, Austria, the U.S.S.R., Japan, Burma, and Ceylon; in addition, some countries sent delegates from their embassies in India.

The visitors first gathered in Bangalore to attend the thirty-eighth session of the Indian Science Congress, held in the first week in January this year concurrently with the inaugural meeting of the Pan Indian Ocean Science Congress. After visiting the Kolar goldfield, the geologists went to Madras and inspected the type localities of the rocks of the charnockite series at St. Thomas's Mount and Pallavaram. The party then flew to Calcutta to attend the centenary celebrations of the Survey, which lasted from January 10 until 14. The most important of these days was January 13, when the commemoration ceremony took place before an audience of some three thousand people in a vast pandal or marquee erected in the quadrangle of the Indian Museum. Mr. N. V. Gadgil, the Minister for Works, Mines and Power, Government of India, presided, in the unavoidable absence in England of the Prime Minister, Pandit Jawaharlal Nehru, who had hoped to be present. The Governors of West Bengal and Bombay were also present.

The ceremony opened with a procession of the principal visitors and the delegates between a double row of girls dressed in white each holding a burning *chiragh* (a small open oil lamp with wick). The lamp-bearers then joined in the procession; and when everyone was seated they sang songs from the Vedas and garlanded the visitors and delegates in typical Indian fashion. A geological relief map of India was unveiled, and also the new crest of the Geological Survey, colourfully illuminated by neon lights. Addresses were then given by Mr. Gadgil, by Dr. Katju, the Governor of West Bengal, and by Dr. W. D. West, director of the Geological Survey of India. Next followed the reading of addresses from learned bodies and Governments, both Indian and overseas. The present writer had the pleasant duty of presenting addresses from the Mineralogical Society of Great Britain and Ireland and from the Geological Society of London; he had the additional happiness of announcing that news had been received during the preceding night that the Geological Society of London had awarded the Lyell Medal to Dr. W. D. West, director of the Survey and the principal organizer of the centenary celebrations. No award could have been more timely and popular.

The same evening a variety entertainment was given in the pandal by the Recreation Club of the Geological Survey. This included a tableau representing a photograph of a group of eight Survey geologists taken about 1868, in which Thomas

Oldham, W. T. Blanford and H. B. Medlicott were included. In those days the geologists all wore beards; and Thomas Oldham (Austin Ghosh), after the tableau was ended, descended among the audience and made the sort of paternal remarks that we might expect from the founder of the Survey. On another evening a tea party in the garden of the Museum House was followed by a fireworks display in which were included a giant representation of the crest of the department, and a portrait of Thomas Oldham, several times life-size.

An important feature of the celebrations was a comprehensive exhibition in the Museum of the originals of the Geological Survey maps on all scales, from the beginning to date, as also of geological maps published in India prior to the formation of the Survey. There was also an exhibition of maps and plans of the engineering projects that now play such an important part in the work of the Geological Survey of India, and of geophysical apparatus used by the Survey. A part of this apparatus had been manufactured in the departmental workshops.

Each delegate was presented with a dissected and mounted copy of a new geological map on the scale of 96 miles to the inch, and also a work specially written for the occasion entitled "Centenary of the Geological Survey of India 1851–1951. A Short History of the First Hundred Years". In addition, we were each given a specially bound copy of the first volume of Sir Edwin Pascoe's "Manual of the Geology of India", but recently published.

The delegates were also entertained in Calcutta at the annual dinner of the Mining, Geological and Metallurgical Institute of India (and in Nagpur at a dinner of the Central Provinces Branch thereof).

On the morning of the last day in Calcutta, the generosity of an Indian friend of the Survey enabled a charter flight to be undertaken to view from the air both Mount Everest and Kangchenjanga. This stimulated one of the delegates, in a speech of appreciation on a suitable occasion, to mention that the visitors had been caused to descend the deepest mine in the world (Ooregum gold mine, 9,500 ft.) and view the highest mountain.

All travel had hitherto been made by air; but on leaving Calcutta the delegates spent ten days in a special train labelled "Geological Survey Centenary Special". During this tour the party visited the coalfields of Raniganj (for sand-stowing) and Bokaro (opencast working of the 100-ft. Kargali seam), the mica industry of Kodarma (the world's richest mica field), the Indian School of Mines, the Fuel Research Institute, the Sindri Fertilizer Plant (planned to make 250,000 tons of ammonium sulphate annually from gypsum), and a dam site of the Damodar Valley Authority. The party also visited the giant opencast iron mines at Noamundi in Singhbhum, the Tata Iron and Steel Works, and the Kandri manganese mine in the Central Provinces (now called Madhya Pradesh). Next the party joined the Geological Survey training camp at Deolapar in the Nagpur District, where some twenty-five young Indian geologists are being inducted into the intricacies of field-work on the tract of Archæan schists and gneisses made classic by the work of West, this being the ground where the existence of an overthrust nappe was proved in the Archæans of the Indian Peninsula. At this camp some 160 tents, large and small, had been pitched, and it is certain that there has never before been such an impressive geological camp in India, and improbable that there will ever be such another. Two nights were spent under canvas, and this experience must be regarded as one of the 'high-lights' of the tour.

Our special train then took us first to Agra and finally to Delhi, where we witnessed the Republic Day celebrations on January 26. The splendour and precision of the parade of military, naval and air-force units on this occasion accorded with the standards of the previous British regime. Departing from the past, however, the parade was followed by a pageant of Indian history from the days of Asoka. The party dispersed at Delhi, after a luncheon party given by the Minister of Works, Mines and Power, at which the Prime Minister was present.

When we visitors were about to disperse in Delhi, it was our unanimous opinion that the organization of the several ceremonies and parties, and of the extensive tour, had been excellent and inspired with imagination; and it was clear that the whole of the staff of the Survey, senior and junior, had thrown themselves into the work of preparation with enthusiasm and efficiency.

The number of geologists on the staff of the Geological Survey is now some 150—many times that at the disposal of Thomas Oldham and his successors. A large proportion of these are young men who have been appointed during the past four years; and the training of so many in field-work, with but few senior men available for the purpose, is a serious problem for the director—a problem that is being tackled in two ways. One method is to send men abroad, as exemplified by a party of nine sent to Melbourne, where Prof. E. C. Hills devised a special course for their benefit. The other method is the establishment of training camps in various parts of India, on different types of geological terrain, of which the Deolapar camp is an example. The expansion of the Survey to its present large size, without the commensurate expansion of the headquarters office, as also the scarcity of residential accommodation in Calcutta, has necessitated the establishment of provincial headquarters at Bombay, Madras, Lucknow and Nagpur.

As geological field-work needs physical fitness, the activities of the Recreation Club at headquarters have been encouraged; and the Geological Survey football team, starting in the fourth division of the Calcutta Office League, has played itself without a halt to the top of the first division. The team is made up from both the scientific and clerical staff at headquarters, not excluding the section cutters.

At the end of January, Dr. West took leave preparatory to retirement, and handed over the keys of office to his successor, Dr. M. S. Krishnan. The Calcutta celebrations may thus be regarded also as a farewell party to Dr. West, a party more magnificent than has been given to any previous director. We must now wish all success during his term of office to Dr. Krishnan, in the heavy task that lies before him of implementing the second five-year plan of expansion of the department that, it is understood, has been sanctioned by the Government of India.

A feature of much interest to the visitors to India during these centenary celebrations has been the attention given to them in the Indian daily Press of all shades of political opinion, as indicated by the full reports and the special articles on geological subjects that have appeared. It is difficult to suppose that any comparable ceremony in Britain would be treated with similar pride, enthusiasm and fullness.

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Finally, one must mention that the Government of India has indicated its approval of the century's work of the Geological Survey of India by the issue of a special centenary postage stamp, which was placed on sale from the date of the commemoration ceremony, namely, January 13, 1951, at a special temporary post office in the entrance of the Indian Museum, as well as at the principal post offices throughout India. This stamp shows two Siwalik elephants (*Stegodon ganesa*) in animated conversation, and is reproduced from a drawing made by Margret Flinsch Buba for Henry Fairfield Osborn's "Proboscidea", published by the American Museum of Natural History. There was also a special cancellation used on the first day of issue only.

L. L. Fermor

OBITUARIES

Dr. Edward Mallett

The death of Dr. Edward Mallett on December 10 removed a notable figure from the field of technical education in Great Britain. For the past eighteen years, Dr. Mallett had occupied the post of principal of Woolwich Polytechnic, and although he maintained throughout his life his scientific interest and activity, he was most widely known in recent years for his administrative work and his influence on technical education.

That Dr. Mallett, when he took up the principalship of a great technical college, already had behind him a distinguished record in research and university teaching is better known to colleagues and students who were in touch with him in the earlier stages of his career. Having chosen electrical engineering for his profession, Mallett went as an undergraduate to University College, London, in 1905 and there, in due course, he came under the stimulating influence of J. A. Fleming. After graduating in 1908, he had a short period of apprenticeship with Cromptons in Chelmsford before entering the service of the Post Office by Civil Service competition in 1909. He was first appointed to the South-West Scotland Division of the Post Office Engineering Department and afterwards to the Transmission Section of the Engineer-in-Chief's office. During the First World War, Mallett held a commission in the 54th and 74th Divisional Signal Companies, part of his service being in the Middle East area.

In the Transmission Section of the Post Office, Mallett had become engaged in a study of the characteristics of telephone receivers and of the modes of vibration of telephone receiver diaphragms. It was evidently this experience which excited his interest in the characteristics of electro-mechanical vibrating systems, a subject which he afterwards studied and advanced in a notable degree. For his work in this field he was awarded the degree of doctor of science by the University of London in 1926.

In 1921, Dr. Mallett was appointed assistant professor of electrical engineering in the City and Guilds College, South Kensington, and for eleven years he co-operated with the late Prof. C. L. Fortescue in the development of teaching and research in telecommunications in the Electrical Engineering Department of that College. It was here that Mallett's fine qualities of intellect and ingenuity in experiment found full scope for their exercise, and his exceptional natural ability as a lecturer for its development. His researches resulted in the publication of a series of scientific papers mainly concerned with telephone circuits and apparatus, and he also wrote one of the first English texts for students in which a comprehensive treatment of the subject of telecommunications was given.

When in 1932 Dr. Mallett became principal of Woolwich Polytechnic, he turned all his ability and energies to the furtherance of the interests of the special group of students with which he was now concerned. He championed the cause of the part-time university student, and he developed, in association with local industry, a 'sandwich' course which has become an important feature of the work of the Polytechnic. It was during this period that Dr. Mallett gave valuable service as a member of the Advisory Committee on Telecommunications of the City and Guilds of London Institute; and throughout practically the whole of his teaching career he was a member of the Board of Studies in Electrical Engineering of the University of London. No one who served with him on any committee could fail to appreciate his keen intellect, his grasp of essentials, his ready wit and his puckish sense of fun. No meeting which Mallett attended was ever dull.

Dr. Mallett was a Fellow of the Institute of Physics, a member of the Institution of Civil Engineers and a member of the Institution of Electrical Engineers. He was chairman of the Wireless Section of the Institution of Electrical Engineers for the session 1937–38.

He will be long remembered by colleagues and students as a man of exceptional ability and great personal charm, who was one of the pioneers to whom the subject of telecommunications owes its establishment in Great Britain as a study of university rank.

James Greig

Prof. H. Tanakadate

Hidezo Tanakadate, the Japanese geologist and geographer, died in Tokyo on January 29, after a serious illness. He was born in Fukuoka-Machi, Iwate Prefecture, in 1884, and was adopted in 1916 by Prof. Aikitsu Tanakadate, the doyen of Japanese physicists, who, I am informed, is yet in good health at the age of ninety-four. Hidezo Tanakadate's first interest was in vulcanology, but through his travels he became an international figure and his attention turned to human geography, of which he was professor at Hosei University at the time of his death.

Tanakadate went to Singapore two days after its surrender in 1942, having flown from Saigon at the earliest opportunity to prevent looting of scientific institutions. He made Raffles' Museum the centre of conservation for historic and scientific records, libraries of all kinds, works of art, etc., which would otherwise have been sold up, looted, or destroyed, and he prevented the occupation of the Botanic Garden and the Nature reserves on the island by the Nippon military. Such was his influence that, when the authorities were contemplating the destruction of Raffles' statue in Empress Place, he had it trans-

ferred to the Museum and set up in the most prominent place in the central hall, where, with notices in Japanese, Malay and English, it remained until the ceremony of restoration in 1946. His part in the issue of *Malayan Forest Records* No. 16 has already been noticed in *Nature* (158, 63). But, apart from having preserved the historic and scientific records of Singapore in 1942, and his similar endeavours in Batavia, Buitenzorg and Medan, he displayed a rare humanity which helped all and sundry, and which made Raffles' Museum a sanctuary in those hostile years. It was his pleasure to be able to say, "Perhaps I only among the Japanese can talk with high officers, coolies, and prisoners"; for which independence he consistently refused offers of high official rank. By ill-fate, his own house and scientific records were destroyed during an air-raid on Tokyo in 1945. There must be many, now scattered over the world, who have felt his grace abounding, and who would join in sympathy with his family.

E. J. H. CORNER

WE regret to announce the following deaths:

Prof. V. F. K. Bjerknes, For.Mem.R.S., the distinguished Norwegian geophysicist and meteorologist, on April 9, aged eighty-nine.

Dr. R. Broom, F.R.S., keeper of physical anthropology and vertebrate palæontology in the Transvaal Museum, Pretoria, aged eighty-four.

Mr. H. Y. Oldham, sometime reader in geography in the University of Cambridge, on March 14, aged eighty-eight.

Mr. W. G. A. Perring, C.B., director of the Royal Aircraft Establishment, Farnborough, since 1946, on April 8, aged fifty-two.

NEWS and VIEWS

Physics at Leeds: Prof. R. Whiddington, C.B.E., F.R.S.

PROF. RICHARD WHIDDINGTON is retiring this summer from the Cavendish chair of physics in the University of Leeds, which he has held since 1919. He was educated at the William Ellis School, London, and then went up to St. John's College, Cambridge. After taking both parts of the Natural Science Tripos he became Hutchinson Student and Allen Scholar and was elected to a fellowship in his College in 1911. He worked at the Cavendish Laboratory as research student and demonstrator until the outbreak of the First World War, and it was in this period that he discovered the well-known 'Whiddington Law' connecting the loss of velocity of an electron with the thickness of material it has penetrated. He also discovered a relation between the velocity of a cathode ray and the atomic weight of the atoms in which it can excite characteristic radiation, which pointed in the direction of Moseley's famous law. When the War came, he took a leading part in the development of airborne wireless telegraphy and telephony, first for the R.F.C. and then for the R.A.F. when this service was formed. Much of this work was done at the Royal Aircraft Establishment and involved flying under somewhat hazardous conditions.

After his appointment to the University of Leeds, Prof. Whiddington continued to work with electrons, examining their energy spectrum after passing through matter. Discrete losses were found, sometimes but not always corresponding to the critical potentials of the molecules. This work has inspired researches of a similar character in other places and has opened up what is still a promising field. In the Second World War, Prof. Whiddington served with the Directorate of Scientific Research, Admiralty, and later he was deputy director of scientific research at the Ministry of Supply. With Mr. J. G. Crowther he wrote "Science at War", a valuable account of the British scientific war effort. Among his many outside interests, Prof. Whiddington is a keen sailor of small boats, and his many friends will wish him much happiness in this and other pursuits at King's Lynn, where he has a house.

Prof. E. C. Stoner, F.R.S.

PROF. E. C. STONER, who is to succeed Prof. Whiddington, was born at East Molesey, Surrey, in 1899 and was educated at Bolton School and Emmanuel College, Cambridge. After graduating in 1921, he spent three years under Rutherford's ægis at the Cavendish Laboratory, working on glow discharges with G. Stead for a year, and then devoting his attention to the subject of X-ray and γ-ray absorption. For this work he was awarded the Ph.D. degree. In 1924 Prof. Stoner went to Leeds as a lecturer in physics and was appointed reader two years later. Emmanuel honoured him with a research fellowship in 1928 (held at Leeds). He was elected to the Royal Society in 1937, proceeded to the Cambridge Sc.D. the following year, and in 1939 became the first occupant of the newly created chair of theoretical physics at Leeds. Prof. Stoner is perhaps best known for his work on magnetism (his books on the subject being particularly well known), an interest which developed out of his early suggestions (1924–25) for modifying the Bohr atomic scheme. His interest in the atomic interpretation of magnetic properties being thus aroused, a number of important papers on the subject followed; particularly remarkable perhaps were two in 1938–39 on collective electron ferromagnetism, a subject which his research students have recently opened up still further. During this time he made occasional digressions into other fields, a specially interesting one being the application of Fermi Dirac statistics and the problem of white dwarf stars. In more recent years his interests have continued in the main general direction of the properties of metals and alloys from an application of quantum mechanics, statistical mechanics and thermodynamics. Besides his research work, Prof. Stoner has been a considerable force within the University of Leeds; he is a first-class teacher and has always taken a full share of the burden which falls nowadays on all professorial shoulders.

Charles Chree Medal and Prize for 1951: Sir George Simpson, K.C.B., C.B.E., F.R.S.

THE Charles Chree Medal and Prize, which is given biennially by the Physical Society for distinguished work in terrestrial magnetism and/or atmospheric electricity, has been awarded to Sir George Simpson, who was for many years director of the British Meteorological Office. The presentation of the Medal and Prize will take place at the Science Museum,

London, on May 25, when Sir George will deliver an address, entitled "Fifty Years' Work in Geomagnetism and Geophysics: Some Reminiscences". Sir George's work covers a wide range, the most important aspects being atmospheric electricity and thunderstorms, terrestrial radiation, climatic changes in geological times, geophysical observations on Captain Scott's last Antarctic Expedition and their discussion, and water vapour and condensation in the atmosphere. Early in his career, Sir George went to Lapland to study atmospherics in high latitudes; but his main work began with his theory of the origin of the electricity of thunderstorms. His most important work was probably that with Scrase and Robinson in the design of a very simple instrument, many of which were sent up by means of balloons into thunderclouds to give a definite indication of the potential gradient and its magnitude. In this way he obtained the first clear picture of the positions of the charges in a thundercloud and their sign. He accompanied Scott on his last expedition to the Antarctic and was in charge of the work on meteorology, atmospheric electricity and terrestrial magnetism. One of the important results of this was a collection of data on the semi-diurnal oscillation of atmospheric pressure and on water vapour condensation in the atmosphere for these high altitudes.

Physical Society: Annual General Meeting

The annual general meeting of the Physical Society will be held on May 2 at 4.30 p.m. in the Lecture Theatre of the Royal Institution, and will be followed at 5 p.m. by an address by Prof. Sydney Chapman, Sedleian professor of natural philosophy in the University of Oxford. Prof. Chapman was president of the Society for the year 1949–50, but was unable to continue his second year of office owing to a long-term engagement in the United States. His subject for this deferred presidential address will be "Some Phenomena of the Upper Atmosphere". Prof. Chapman is mainly known for work on three aspects of research on the earth's atmosphere. In the late 1920's he worked largely on the turbulent transfer of heat in the lower atmosphere. He then turned his attention to the constitution of the upper atmosphere and considered in particular the balance of atomic oxygen, molecular oxygen and ozone in the atmosphere, and the relation of this balance to auroras. This latest work has been in connexion with the determination of the lunar atmospheric tides at a number of stations distributed over the whole world.

New B.B.C. Transmitter

A marked technical advance in the distribution of the 'Third Programme' of the B.B.C. materialized on April 8, when a new high-power transmitter was brought into operation at Daventry. Since the Copenhagen plan of wave-lengths for European broadcasting stations came into operation in March 1950, the Third Programme has been radiated on two wave-lengths, 464 m. (647 kc./s.) and 194 m. (1,546 kc./s.), using twenty-three transmitters to give a service to about fifty per cent of the population. With the new transmitter installed at Daventry, the power radiated from this station on the 464-m. wavelength has been increased almost three-fold to 150 kW., the maximum permitted under the Copenhagen plan. The new installation consists of two identical self-contained transmitters, each giving an output of 100 kW. They are normally operated in parallel at reduced power; but should a fault occur on one, it can be switched off and the other brought up to full power for the short time necessary to locate and correct the fault. This is a more economical method of maintaining a virtually uninterrupted programme than that of using two separate transmitters—one in operation and one spare—each capable of the full power output needed. Another feature of the new station is that it is provided with a single mast-radiator, 725 ft. high, erected on a site 460 ft. above sea-level, at a distance of a mile and a quarter from the transmitter building. The feeder from the transmitter is connected to this aerial at such a height as will concentrate the maximum radiation along the ground. The combined features of high power and more efficient aerial are expected to result in good non-fading reception over an area of a radius of at least a hundred miles. This area is bounded by a circle approximately through Manchester, Grimsby, Ipswich, Chatham, Southampton and Cardiff; and with the supplementary transmissions already in operation, it should bring the number of listeners able to receive the programme up to about seventy per cent of the population.

Leaf Scald Disease of Sugar Cane in British Guiana

Leaf scald disease, a bacteriological disease of extreme virulence which causes the sugar cane to wither and reduces its yield of sugar by fifty per cent or more, has recently been discovered on the sugar estates in British Guiana. It has previously been reported from sugar-growing areas in Mauritius, Queensland and Hawaii, where it was eventually brought under control by breeding resistant strains and enforcing plant-hygiene measures; but this is the first recorded case in the West Indian region. Mr. P. O. Wiehe, plant pathologist to the Government of Nyasaland, is to be seconded to British Guiana for six months to carry out research on the disease. The cost of Mr. Wiehe's visit is being shared equally between the British Guiana Government, the sugar industry in British Guiana and a grant made under a Colonial Development and Welfare Research Scheme.

Echo-Sounding for Fish

The Lowestoft Laboratory has issued a second report on the application of echo-sounding to fish-finding—especially in the pelagic fisheries—which bears the title "Echo-Sounding and the Pelagic Fisheries" (Ministry of Agriculture and Fisheries. Fishery Investigations, Series 2, 17, No. 4; pp. 25; London: H.M. Stationery Office; 3*s*.). The efficacy of the modern echo-sounder for this purpose can now be considered proved; but improvements are possible and even now are on the way. Not only can fish shoals now be located with accuracy and ease in the wheelhouse, but also, perhaps even more important, is the fact that the echo-traces produced by certain kinds of fish—for example, herrings, pilchards, mackerel, sprats and certain gadoids—are shown to have recognizable characteristics that identify the species producing them. The fishing industry will be much indebted to Dr. W. C. Hodgson, the author of the report, and his colleagues for their pioneer work in this field.

Bibliography of Scientific Publications of South Asia

The second number of the "Bibliography of Scientific Publications of South Asia (India, Burma, Ceylon)", covering July–December 1949 (Pp. 88.

Delhi: Unesco Science Co-operation Office for South Asia, 1950), is a supplement to the first in that the complete list of periodicals is not repeated, only new periodicals and changes being indicated. Books, monographs, pamphlets and reports are included, as well as periodical entries, and these accordingly cover both halves of 1949. Some cross-references are given, and the bibliography is now printed instead of being duplicated. Assistance in locating new books and institutional reports is requested. Very few publications have come from Burma, and the entries relate mainly to India and Ceylon.

Liverpool and Manchester Geological Journal

THE Liverpool Geological Society and the Manchester Geological Association have decided to amalgamate their publications now appearing as the *Proceedings of the Liverpool Geological Society* and the *Journal of the Manchester Geological Association*. The new publication, which will be annual, will be entitled *The Liverpool and Manchester Geological Journal*, and the first part will appear in the autumn of this year. The price of each part to members of the public will be 10*s*. 6*d*. It is hoped that those who have papers for publication on the geology of Lancashire, Cheshire, North Wales, the Lake District, the Isle of Man and adjacent districts will consider using this new *Journal*. Work of a more general nature will also be considered. Manuscripts should be submitted by May 1 each year. Further information can be obtained from either of the joint editors: John C. Harper, Liverpool Geological Society, Department of Geology, University of Liverpool, Liverpool 3; F. M. Trotter, Manchester Geological Association, Geological Survey Office, 250 Oxford Road, Manchester 13.

University of London

THE following appointments in the University of London have been announced: Prof. J. N. Findlay to the University chair of philosophy tenable at King's College, from October 1; and Mr. Bernard Atkins to the University readership in electrical engineering tenable at the Imperial College of Science and Technology, from October 1. The title of reader in pure mathematics in the University has been conferred on Mr. Leonard Roth, in respect of the post held by him at the Imperial College of Science and Technology.

Summer School and Conference on Dielectrics

A SUMMER School on the "Theory of Dielectrics" will be held at the University of Liverpool during July 19–21. Lectures will be given by Prof. H. Fröhlich, Dr. B. Szigeti and other members of the Department of Physics. The course, which is being arranged by the University of Liverpool in co-operation with the Institute of Physics and the British Electrical and Allied Industries Research Association, is intended mainly for research workers in Government and industrial research laboratories who wish to familiarize themselves with the theoretical aspects of subjects with which they are concerned on the experimental side. The Summer School will be followed by a Conference on "Dielectrics" during July 23–25. The speakers will include Dr. L. Hartshorn, Prof. H. Fröhlich, Prof. J. C. Slater, Dr. M. Magat, Prof. C. P. Smyth and Dr. S. Whitehead. Particulars of both Summer School and Conference may be obtained from Dr. Szigeti, Department of Physics, University, Liverpool, 7, or from the deputy secretary of the Institute of Physics, 47 Belgrave Square, London, S.W.1.

Announcements

THE honorary degree of LL.D. of the University of Aberdeen has been conferred on Lord Robinson, chairman of the Forestry Commission.

A SUMMER laboratory course in "Techniques and Applications of the Electron Microscope" will be given again this year by the Laboratory of Electron Microscopy, Cornell University, during July 9–21. The course is designed for research workers, academic and industrial, who are new to the subject or who plan to use the electron microscope in other research fields. Further details can be obtained from Prof. Benjamin M. Siegel, Department of Engineering Physics, Rockefeller Hall, Cornell University, Ithaca, New York.

AIR MARSHAL SIR VICTOR GODDARD has been appointed principal of the College of Aeronautics, Cranfield, Beds, in succession to Mr. E. F. Relf, who is retiring. Mr. Relf has been principal since the opening of the College in 1946 (see *Nature*, 156, 623; 1945).

MAJOR F. B. HALFORD, vice-president of the Royal Aeronautical Society, has been elected president of the Society for the year 1951–52. Major Halford is chairman and technical director of de Havilland Engine Co., Ltd., and director of the de Havilland Aircraft Co., Ltd.

THE Chemical Society invites applications for grants for research in all branches of chemistry. Such applications must be submitted on the appropriate form, not later than May 1, to the General Secretary, Chemical Society, Burlington House, Piccadilly, London, W.1, from whom further particulars can be obtained.

THE sixteenth Cold Spring Harbor symposium on quantitative biology, to be held during June 7–15, will be on "Genes and Mutations". The following topics will be discussed: gene concept, cytoplasmic constituents of heredity, evolution of the gene, induction changes in genes and chromosomes, genetic mechanisms in bacteria and bacterial viruses, and conclusions and perspectives. Further information can be obtained from the Biological Laboratory, Cold Spring Harbor, New York.

THE Institute of Personnel Management is arranging a conference for overseas visitors on "Personnel Management in Great Britain, its Contribution to Productivity", to be held at St. Catherine's College, Cambridge, during June 26–29. Accommodation is limited to seventy overseas visitors and thirty from Great Britain. Application forms, obtainable from the conference secretary at the Institute of Personnel Management, Management House, 8 Hill Street, London, W.1, must be completed by June 11.

ERRATUM. In the article on the annual report for 1949–50 of the Overseas Food Corporation, published in *Nature* of March 31, p. 516, it was stated (p. 517) that 1,200 acres should be cropped during the next three years, out of 94,000 acres cleared. This is incorrect; the Kongwa 'working party's' report recommended cultivating an area of approximately 12,000 acres.

MECHANICS OF LARGE ELASTIC DEFORMATIONS WITH SPECIAL REFERENCE TO RUBBER*

By R. S. RIVLIN

Davy Faraday Laboratory, Royal Institution, London, and British Rubber Producers' Research Association

THE main problem of the mathematical theory of elasticity is the correlation of load-deformation relations for perfectly elastic solids of various shapes and loaded in various manners under isothermal conditions.

Since its formulation by Cauchy early in the nineteenth century, for isotropic materials subject to infinitesimally small deformations, the mathematical theory of elasticity has been a popular field of study among mathematicians, physicists and engineers, and as a result has undergone an impressive development. Although in practice we are always concerned with finite deformations, the assumption in the theory that the deformations are infinitesimal does not, for the most part, lead to appreciable error for those deformations of a metal or other hard elastic solid which do not cause it to exceed its elastic limit.

However, even for such a material deformed within its elastic range, small departures from the predictions of the theory can be detected. This has been very strikingly demonstrated by Poynting. He subjected a long thin steel wire, maintained at a constant tension, to a torsional couple and measured the dependence of the length of the wire on the amount of torsion. For infinitesimal torsions, the theory predicts that the application of a torsional couple to the wire will produce a simple torsion, leaving its length unchanged. Poynting found that the wire elongated by a small amount proportional to the square of the amount of torsion.

By far the greater part of the work that has so far been carried out on the mathematical theory of elasticity has involved the assumption that the deformation is infinitesimally small. This assumption results in a simplification which renders a very large number of particular problems tractable. For highly elastic materials such as vulcanized rubber, which are capable of undergoing substantially reversible deformations of a few hundred per cent, it is not possible to make the assumption that the deformations are infinitesimal with any measure of accuracy.

However, it is still possible to develop a theory which, in principle, enables us to interpret the load-deformation relations for various types of deformation in terms of each other. The basic assumptions regarding the material on which such a theory may be based are the following:

(i) the material is a continuum, homogeneous in its undeformed state;

(ii) it is perfectly elastic in the sense that the work done by the externally applied forces in deforming a body of the material quasi-statically and isothermally produces a change in the free energy of the material which is uniquely dependent on the state of deformation and is quite independent of the path by which this is reached; and

(iii) the material is isotropic.

The whole of the mathematical theory of the deformation of highly elastic materials may be derived by the systematic development of these three assumptions.

We first consider (Fig. 1) the deformation of a unit cube of highly elastic material into a cuboid, by means of a pure homogeneous deformation in which a point initially at (x, y, z) moves to $(\lambda_1 x, \lambda_2 y, \lambda_3 z)$. The quantities λ_1, λ_2 and λ_3 are termed the principal extension ratios for the deformation. Assumption (ii) implies that the change of free-energy W in the deformation must be a function of λ_1, λ_2 and λ_3 only, since these are the only parameters defining the deformation. Furthermore, W must be an even function of the λ's and must therefore be expressible as a function of λ_1^2, λ_2^2 and λ_3^2, since a change of sign of two of the λ's merely represents a rotation of the cuboid, into which the cube is deformed, through 180° about one of its edges. Such a rotation cannot alter the free energy of the body. Again, from the assumption that the material is isotropic, it is clear that W must be a symmetrical function of λ_1^2, λ_2^2 and λ_3^2. It can therefore be expressed in terms of any three independent symmetrical functions of λ_1^2, λ_2^2 and λ_3^2, and it is mathematically most convenient to choose for these the expressions I_1, I_2 and I_3 defined by the relations: $I_1 = \lambda_1^2 + \lambda_2^2 + \lambda_3^2$, $I_2 = \lambda_2^2\lambda_3^2 + \lambda_3^2\lambda_1^2 + \lambda_1^2\lambda_2^2$ and $I_3 = \lambda_1^2\lambda_2^2\lambda_3^2$.

In principle, the manner in which W depends on I_1, I_2 and I_3 for any particular material must be determined by experiment. Once it has been determined, we can in principle calculate the forces which must be applied to maintain any deformation in a body of any shape provided the deformation is completely specified, in the sense that the displacement undergone by each point of the body is known both in magnitude and direction. This was realized by Green and by Kirchhoff as early as the middle of the last century.

The difficulties that arise in the solution of most problems of practical interest are those of determining the appropriate form for W, and the fact that the deformation is incompletely defined. Many workers in this field have attempted to overcome the first of these difficulties by making *ad hoc* assumptions regarding the form of W on the basis of simplicity, as judged by one criterion or another. Others, notably Murnaghan, have limited their theory to small deformations so that an approximation to the stored-energy function of a degree higher than that involved in the classical elasticity theory is valid. Both these difficulties are rendered somewhat less serious if the assumption is made that the material is incompressible—an assumption that is valid to a

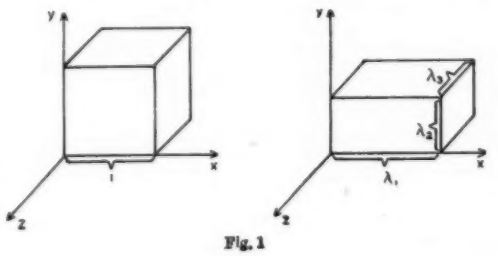


Fig. 1

* Based on four lectures given at the Royal Institution on January 25 and February 1, 8 and 15.

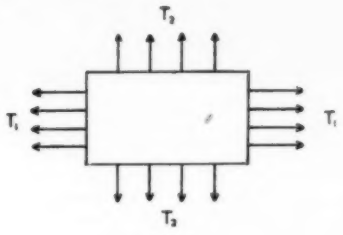


Fig. 2

high degree of accuracy for vulcanized rubber. Then, $\lambda_1\lambda_2\lambda_3$ (the volume of the cuboid in Fig. 1) is equal to unity (the volume of the cube) so that $I_3 = 1$. Thus, for an incompressible material the free energy of deformation is a function of only two quantities, I_1 and I_2, which may now be written as :

$$I_1 = \lambda_1^2+\lambda_2^2+1/\lambda_1^2\lambda_2^2, \text{ and } I_2 = 1/\lambda_1^2+1/\lambda_2^2+\lambda_1^2\lambda_2^2.$$

It can then be shown that, in order to deform a square sheet of the material of unit edge and thickness h into a rectangular sheet of edges λ_1 and λ_2, we must pull apart both pairs of opposite sides with forces T_1 and T_2 (Fig. 2), uniformly distributed along the sides, such that

$$T_1 = 2h\left(\lambda_1 - \frac{1}{\lambda_1^2\lambda_2^2}\right)\left(\frac{\partial W}{\partial I_1} + \lambda_2^2\frac{\partial W}{\partial I_2}\right)$$

and

$$T_2 = 2h\left(\lambda_2 - \frac{1}{\lambda_2^2\lambda_1^2}\right)\left(\frac{\partial W}{\partial I_1} + \lambda_1^2\frac{\partial W}{\partial I_2}\right),$$

where $\partial W/\partial I_1$ and $\partial W/\partial I_2$ are, in general, functions of I_1 and I_2.

The dependence of T_1 and T_2 on λ_1 and λ_2 has been measured for a sheet of vulcanized rubber, in which λ_1 and λ_2 were varied together in such a way that either I_1 remained constant while I_2 varied, or I_2 remained constant while I_1 varied. For each state of deformation of the sheet, the formulæ for T_1 and T_2 can be solved to give values for $\partial W/\partial I_1$ and $\partial W/\partial I_2$ at the values of I_1 and I_2 corresponding to this state of deformation. The experiments indicated that $\partial W/\partial I_1$ was substantially constant—independent of both I_1 and I_2—while $\partial W/\partial I_2$ decreased as I_2 increased, from a value of about $\frac{1}{2}\partial W/\partial I_1$ when $I_2 = 5$.

For values of I_1 or I_2 less than about 5, the method becomes too inaccurate to be of any value, and it is therefore necessary to have resort to other experiments in order to determine the manner in which $\partial W/\partial I_1$ and $\partial W/\partial I_2$ depend on I_1 and I_2 for these lower values. Three experiments that involve particular types of homogeneous two-dimensional deformation of a sheet, but are capable of much greater accuracy than the experiment described above, have been carried out. These are : *pure shear*, in which λ_3 is maintained at the value unity, while the dependence of T_1 on λ_1 is determined ; *simple extension*, in which λ_1 and λ_2 vary together in such a way that $\lambda_2 = \lambda_1^{-1/2}$, so that $T_2 = 0$, and the dependence of T_1 on λ_1 is determined ; and *pure homogeneous deformation*, in which λ_2 is maintained at some constant value less than unity, while the dependence of T_1 on λ_1 is determined.

From these experiments, which can be conveniently carried out for values of I_1 and I_2 less than about 5 and only slightly greater than 3 (the lowest value which I_1 or I_2 can take, corresponding to the undeformed state of the material), $\partial W/\partial I_1$ and $\partial W/\partial I_2$ are found to behave in a similar manner to that indicated by the earlier experiments, namely, $\partial W/\partial I_1$ is a constant and $\partial W/\partial I_2$ decreases as I_2 increases. It should be borne in mind, however, that for a natural rubber vulcanizate such as that used in the experiments, crystallization may take place when the deformation is sufficiently large, leading to an appreciable irreversibility in the load-deformation characteristics and consequent inapplicability of the theory. This sets an upper limit to the deformation which could be employed in each of the experiments.

The results of these experiments have been applied to explain the forms of a number of load-deformation characteristics of rubber test-pieces subjected to more complex types of deformation. For example, it has been calculated that a right-circular cylinder of the incompressible highly elastic material may be maintained in a state of simple torsion by means of forces applied to its ends. These consist of forces Θ per unit area acting tangentially to the ends of the deformed cylinder in an azimuthal direction, and of forces Z per unit area acting at right angles to the ends of the cylinder.

The values of Θ and Z at any point depend on the radial distance r of that point from the axis of the cylinder, Θ and Z being given by :

$$\Theta = 2\psi r\left(\frac{\partial W}{\partial I_1} + \frac{\partial W}{\partial I_2}\right)$$

and

$$Z = -2\psi^2\left(\int_r^a r\frac{\partial W}{\partial I_1}\,dr + r^2\frac{\partial W}{\partial I_2}\right),$$

where ψ is the amount of torsion (proportional to the angle through which one end of the cylinder is rotated relative to the other), and a is the radius of the cylinder. As has been already pointed out in connexion with Poynting's experiment, the existence of the forces Z is contrary to the predictions of the classical elasticity theory for infinitesimal deformations.

The distribution of the force Z over the ends of a rubber cylinder subjected to torsion and its dependence on the amount of torsion ψ have been investigated experimentally, and it was found to have the nature of a thrust, proportional at each point to the square of the amount of torsion and distributed, for each state of torsion, in a parabolic manner over the end of the cylinder. If the values for $\partial W/\partial I_1$ and $\partial W/\partial I_2$ found by experiment are introduced into the formula for Z, then its dependence on ψ and r can be reproduced within the limits of experimental error.

The distributed tangential forces Θ are equivalent to a couple, and the distributed forces Z to a thrust acting on the cylinder. These can be calculated from the equations for Θ and Z and measured directly for a rubber cylinder subjected to torsion. The manner in which they are found to depend on the amount of torsion is again in agreement with that predicted from the measured dependence of $\partial W/\partial I_1$ and $\partial W/\partial I_2$ on I_1 and I_2. A similar agreement has been found for a variety of other types of deformation.

It seems that the type of dependence of W on I_1 and I_2 which is thus established is fairly characteristic of a wide range of vulcanized rubber compounds ; but its detailed interpretation in terms of the molecular structure of the rubber vulcanizate remains to be studied. There remains, too, considerable scope for the mathematical solution of problems of greater and greater complexity and practical interest.

SULPHYDRYL-DISULPHIDE RELATIONSHIPS IN THE INDUCTION OF GELS IN PROTEINS BY UREA

By Prof. CHARLES HUGGINS, DONALD F. TAPLEY and ELWOOD V. JENSEN
Nathan Goldblatt Memorial Hospital for Neoplastic Diseases, University of Chicago

CONCENTRATED urea has two opposite solubility effects on protein solutions. Gels of certain proteins, such as gelatin or fibrin, dissolve rapidly upon the addition of urea, while solutions of proteins such as egg-white, serum albumin and globulin are converted by strong urea solutions into firm transparent gels[1,2]. Guanidine hydrochloride possesses similar coagulative properties[3]. The formation of gels by urea requires rather concentrated protein solutions; in more dilute solutions, the addition of urea causes a marked increase in viscosity[4] but no gelation occurs. In this communication it will be demonstrated that sulphydryl groups are essential to the production by urea of gels in serum albumin and γ-globulin. The facts are best explained by postulating a linking together of protein molecules by means of a sulphydryl-disulphide chain reaction.

In the present study, crystalline bovine plasma albumin and egg albumin and refined fractions of bovine γ-globulin and fibrinogen were investigated. Plasma albumin was alkylated by treatment with iodoacetamide or sodium iodoacetate at *p*H 7·4 and 37° C. for 24 hours and afterwards dialysed and freeze-dried; amperometric titration[5] indicated complete absence of sulphydryl groups. Unless otherwise stated, all the experiments were carried out in 13 mm. × 100 mm. glass tubes at 37° C. with the proteins dissolved in *M*/10 phosphate buffer; the volume of the system was 2·5 ml., the final concentration of urea was 8 *M* and the *p*H was close to 8. By definition, a gel was present when the protein solution did not pour on inversion of the tube; the tubes were observed for at least one week.

Characteristics of amide-induced gelation of proteins. The minimum concentration of the amide required to form gels in 5·6 per cent plasma albumin solutions was for urea 5·5 *M* and for guanidine hydrochloride 3·2 *M*. The lowest protein concentrations which would form a gel in 8 *M* urea were 3·2 per cent egg albumin, 3·4 per cent plasma albumin and 5·6 per cent γ-globulin. In contrast to its dispersive effects on fibrin, urea induced firm gels in 8 per cent solutions of fibrinogen. Acetylated[6] plasma albumin does not gel in urea. Gelation is influenced by *p*H; in 5·6 per cent plasma albumin in 8 *M* urea at *p*H 7 gels formed in about sixteen hours, while at *p*H 11 the time required was 30 minutes. The speed of coagulation of albumin by urea is increased when the oxygen tension is decreased. With degassed solutions in evacuated tubes, gels formed within one hour after mixing, while, in control experiments done in the presence of air, gelation occurred in about eight hours.

Sulphydryl groups and urea-induced gelation of albumin. In crystallized plasma albumin (human or bovine) about 70–80 per cent of the protein molecules contain one free sulphydryl group[7,8]. This group plays an important part in the urea-induced gelation of albumin. The effect may be demonstrated either by preliminary elimination of the —SH in the protein or by adding sulphydryl reagents at the time of mixture of protein and urea.

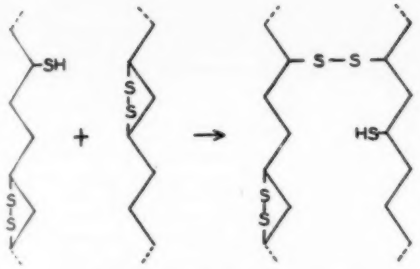
When minute amounts of various reagents, which have the common property of destroying —SH groups, are mixed with 5·6 per cent plasma albumin in 8 *M* urea, gelation does not occur. These sulphydryl reagents include the alkylating agents iodoacetate and iodoacetamide; mercaptide-forming reagents, silver nitrate, mercuric chloride and cupric nitrate; and the oxidizing agents iodosobenzoate, hydrogen peroxide, and iodine (in potassium iodide). The smallest amount of these sulphydryl reagents required to prevent coagulation of 5·6 per cent plasma albumin was determined; in each case it was 1 equivalent of reagent per mole of protein, except that 2·5 equivalents of iodine were required. With extremely concentrated (20 per cent) albumin solutions, iodoacetamide completely prevents gel formation at *p*H 7·4 but at *p*H 8·2 it merely delays the process greatly; at the higher *p*H in the presence of 10 equivalents of iodoacetamide per mole of protein, gelation occurred in albumin after five days, while a similar protein solution containing 10 equivalents of acetamide coagulated in five minutes. This sulphydryl influence applies only to the gelation process in concentrated protein solutions; addition of urea to dilute albumin solutions results in an increase of viscosity whether the —SH group is present or not.

Further, 5·6 per cent solutions of plasma albumin which had been previously treated with iodoacetamide or iodoacetate did not form a gel in 8 *M* urea in two months; the addition of 0·5–1·0 mole of mercaptoethanol per mole of protein after this long time induced gelation within 1 hour, and 0·1 mole of added mercaptan caused a gel to form in 3 days.

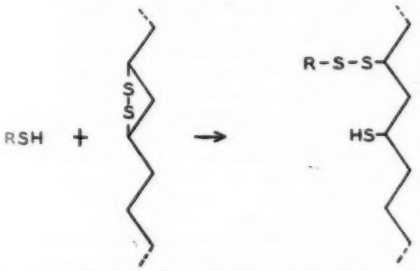
The addition of very small amounts of cysteine or mercaptoethanol enhances the rate of gelation of unmodified albumin by urea. The maximum enhancement occurs with 10 μM of mercaptan per μM of albumin; with larger amounts of added mercaptans, gelation is retarded and finally abolished. Previously formed urea–albumin gels are readily dissolved upon addition of mercaptans in 0·1–0·2 *M* concentration, the rate of dispersion depending on the area of the gel exposed to the mercaptan solution.

The urea-induced gelation of γ-globulin was similar to that of albumin in that gelation was enhanced by small amounts of added mercaptans and abolished by sulphydryl reagents such as silver ion or iodoacetate. Our sample of γ-globulin contained 0·07 moles of sulphydryl per mole of globulin, and the minimum protein concentration required for gelation in urea was about twice as great as albumin. The addition of very small amounts of albumin causes γ-globulin to form a gel in urea in a mixture containing half the protein concentration otherwise required with γ-globulin as the only protein; albumin does not need sulphydryl groups to exert this effect, since the same quantitative enhancement of globulin gelation was observed using iodoacetamide-treated albumin which contained no —SH. In accord with the following discussion, this effect may result from the ability of albumin to furnish disulphide groups more reactive toward mercaptans than the disulphide groups of globulin[9].

Discussion. It has been postulated that in a protein coagulum adjacent molecules are held together by intermolecular hydrogen bonds[10]. This concept satisfactorily explains network formation in protein gels such as fibrin and gelatin which are



$$2R'SH + RS{-}SR \rightleftarrows R'S{-}SR' + 2RSH \qquad (II)$$



dispersed by solutions of urea or guanidine hydrochloride, agents generally considered to disrupt hydrogen bonds in protein molecules. However, in the case of protein gels formed by the action of concentrated urea or guanidine hydrochloride, a different type of cross-linkage appears to be involved.

Serum albumin contains on the average a little less than one free —SH group per protein molecule[7,8]. The effectiveness of sulphydryl reagents in preventing urea-induced gelation of albumin when present in 1, but not in 0·5, molar equivalent amounts demonstrates that this single —SH group is a critical factor. The aggregation of denatured protein to form a three-dimensional gel network requires cross-linking at more than one point in the protein molecule: therefore dependence of the phenomenon on a single group suggests a chain-type of mechanism. A reasonable explanation of our experimental results is that, in the presence of urea, a consecutive process occurs in which the free sulphydryl group of one albumin molecule reacts with a disulphide group in a neighbouring molecule to form an intermolecular disulphide bond while generating a new —SH group (equation I). This new —SH group then reiterates the process either by reaction with another disulphide group in the first albumin molecule or with a similar group in a third molecule and so on. 'Mercaptan interchange' reactions of this type are believed[11] to be intermediate in the reversible reduction of disulphides by excess mercaptans according to equation II.

The foregoing hypothesis explains a number of experimental observations. Non-protein sulphydryl compounds should be equally as effective as albumin in initiating the reaction chain (equation III). This was found to be true experimentally; minute amounts of added mercaptans enhance urea-induced gelation and also restore the gel-forming ability to iodoacetamide-treated albumin. The chain nature of the reaction is substantiated by the fact that restoration of the ability of iodoacetamide-treated albumin to form a gel can be effected by so little as 0·1 mole of mercaptan per mole of protein. When the amount of added mercaptan exceeds a certain critical level, urea-induced gelation of albumin is inhibited. This would be expected when the concentration of non-protein sulphydryl reaches a point where reaction III occurs to the exclusion of reaction I. The increased rate of gelation under anaerobic conditions results from elimination of the chain-breaking reaction of oxygen with the sulphydryl group.

The rapid dispersion of urea-induced gels upon subsequent addition of mercaptans suggests that the gel network is broken by disulphide cleavage (equation II). It is uncertain whether the disulphide bonds cleaved are those of the original protein molecules or cross-linkages formed according to equation I; the effect, however, demonstrates that disulphide bonds are important links in this type of gel structure.

In summary, urea disrupts the structure of certain proteins such as plasma albumin, making disulphide groups reactive to small concentrations of sulphydryl. By means of a chain reaction between protein sulphydryl and disulphide groups, a reticulum is knitted consisting of intermolecular protein disulphide bonds which hold together the protein chains. Solvent is bound to the protein within this framework and clear firm gels result.

This investigation was aided by grants from Mr. Ben May, Mobile, Alabama, from the Daisy Schwimmer Fund, from the Anna S. Goldberg Scholarship Fund and from the American Cancer Society recommended by the National Research Council Committee on Growth.

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USE OF BAGASSE FOR THE MANUFACTURE OF WRAPPING PAPER

IN these times in Great Britain when the supply of paper of all types is becoming very restricted, it is of interest and importance to learn that some poor-quality paper can be made from a waste product. A booklet on the "Utilisation of Bagasse for Wrapping and Bag-Paper Manufacture" by the Chief Research Officer, with collaborators, at the Forest Research Institute, Dehra Dun, has been published as Indian Forest Bulletin No. 148*.

Bagasse is the fibrous material which results from the crushing of sugar cane in the sugar mills, and it is at present consumed as fuel for the boilers in the sugar mills; the large quantity of bagasse produced in the rural 'gur' industry is also used as fuel. It is pointed out that, if coal were used as fuel

* Indian Forest Bulletin No. 148: Utilisation of Bagasse for Wrapping and Bag-Paper Manufacture. By M. P. Bhargava, Dr. G. S. Kasbekar and R. P. Bhargava. Pp. ii+18. (Dehra Dun: Forest Research Institute, 1950.) 10 annas; 1*s*.

in the sugar mills, bagasse could be released for kraft paper manufacture. Enormous amounts of this material, when available, are used in the bazaars of India. The Bulletin sets forth the methods by which bagasse can be utilized in the manufacture of kraft paper for wrapping purposes and for use in multi-wall bags as substitutes for jute bags, and goes closely into the results of the laboratory and pilot-plant tests on bagasse as a source of paper.

The wrapping-paper industry in India is still in its infancy. It was only in 1940 that production of kraft paper was commenced by two mills, based on the results of investigations carried out at the Forest Research Institute, Dehra Dun, on bamboos. Of the two mills, one stopped manufacturing kraft paper in 1942, and the production of the other averages 25–30 tons a day, equivalent to 7,500–9,000 tons a year. As against this, the imports of kraft paper by India (undivided) in the pre-war period were of the order of 13,000 tons a year, and of other varieties of wrapping paper approximately another 12,000 tons a year. There is little doubt that demand for kraft papers has considerably increased of late. In 1946 the Paper Panel appointed by the Government of India estimated that by 1951 the annual requirements of wrapping papers for India (undivided) was likely to be 80,000 tons, and by 1956 it would be 100,000 tons.

With the partition of India, many problems have had to be faced, and one of considerable importance is the shortage of jute, which is required for manufacture of bags used for packing sugar, cement, grains, etc. The sugar industry alone is estimated to require well over twelve million bags a year, and the cement industry needs approximately twice that number. Recently, sugar and cement factories have had to curtail or temporarily stop production owing to shortage of jute bags. In foreign countries, particularly in those which are rich in cellulosic materials, it has become a common practice to substitute multi-wall paper bags for jute bags, and the former have successfully replaced the latter for numerous purposes.

OIL INDUSTRIES EXHIBITION

THE Shell Petroleum Company in association with the Anglo-Iranian Oil Company are holding this year an exhibition of the oil industry at a number of universities in Great Britain. The exhibition is concerned with all phases of the industry; but chief emphasis is laid on oilfield exploration and development. Its main purpose is educational and, although primarily of general university appeal, it is also aimed at attracting the interested public; much care has been taken to present the more specialized aspects of the industry in as clear a manner as possible. It is fitting that the exhibition should emphasize oilfield exploration and development, the importance of which is not generally appreciated by those in Great Britain unfamiliar with the industry. It is in these fields that there has perhaps been the greatest development of new techniques in recent years, as a result of co-ordinated research in many branches of science in which academic research on fundamentals has played a large part.

The exhibition was opened on April 5 by Sir Henry Tizard, chairman of the Advisory Council on Scientific Policy, under the auspices of the Institute of Petroleum, in the Geology Department of the Royal School of Mines, London, S.W.7, where it will remain open until April 21. Afterwards it will move to the Royal Technical College, Glasgow, during May 4–19, the University of Leeds, June 20–July 6, and the University of Cambridge, July 16–28. In opening the exhibition, Sir Henry spoke of the great economic importance of the oil industry and the need for maintaining its close association with the universities. Through technical efficiency the industry has met changing economic conditions with resource and enterprise.

Each visitor to the exhibition is provided with a guide which indicates the four main sections: oilfield exploration and development, transport, refining and manufacture, and distribution and products. The first part of the exploration and development section is an area display consisting of a series of attractively designed panels each illustrating oil operations in one of about twenty Commonwealth and foreign countries. As an introduction there is a large world map by Bip Pares, the well-known designer and economist, which shows the distribution of oilfields in the sedimentary basins of the world. In order to portray the great range of operations undertaken by oil companies at the present time, certain aspects have been chosen for display in each country: the Canadian panel, for example, emphasizes the important Alberta oil basin and includes a section across the basin showing the development of the oil-bearing coral reefs in this area. Other panels show such operations as: exploration in the tropics, the Trinidad Pitch Lake, and marine drilling off the coasts of Louisiana and Texas. On the Venezuelan panel the sociological influence of oilfield developments in remote areas is shown in a series of photographs of the new town of Cardon, which was built on a desert to provide amenities for refinery workers. From the point of view of local interest, there is a number of gravity and magnetic maps of southern England which have been prepared by the Anglo-Iranian Oil Co., and which are shortly to be published by the Geological Society.

The technical display which follows also consists of a series of panels presenting a comprehensive picture of the specialized techniques required in modern oilfield work. The fundamentals of geology and geophysics in relation to oilfield exploration are illustrated by a series of diagrams, and of especial interest is a chart showing the relative importance of technical surveys, in which the trends in geological and geophysical exploration methods during the past four decades are clearly shown. A series of coloured drawings outlines the current theory of the origin of petroleum, from the burial of organic material in fine-grained sediments and its transformation to oil, to the migration of the liquid petroleum to the reservoir rocks. Methods of exploration which are illustrated include aerial survey and photogeology, which are now widely used in the initial phases of exploration in unknown areas, and geophysical prospecting, which assists the geologist in the interpretation of subsurface geological structure by the application of physical methods at the surface.

The exploitation of an oilfield is illustrated by panels which show the drilling of oil wells by the rotary method, the techniques used in oilfield geological correlation, and problems related to the oil reservoir; in addition, there is a number of models and examples of oilfield equipment such as well-casing, drilling bits, and a model derrick. In the early stage of development of an oilfield the determination of the geological structure of the oil reservoir is essential to the efficient planning of the complete development programme, and a special exhibit

demonstrates the various methods, both old and new, which are used to correlate geological formations from well to well, thus enabling the underground geological structure to be determined. A panel which discusses oil reservoir problems directs attention to one of the most important problems of the industry at the present time, that of producing all the oil contained within the reservoir rock; at the best, current production practice may recover only about 75 per cent of the oil originally stored within the reservoir.

The final sections on transport and refining, and distribution and products, also contains maps by Bip Pares, one of which, namely, that illustrating the world movement of oil in relation to tanker movements, is on an original projection. Of special interest is a series of photographs illustrating the construction of a pipe-line, and the cathodic protection methods employed to combat corrosion. A novel exhibit in the section on refining methods is a large coloured flow-chart which outlines the main refining processes, and of more specialized interest there is a number of smaller panels each illustrating in detail the stages of one refining process and including within the panels samples of the refined products. Another map shows the position of refineries in Great Britain and directs attention to the great development in refining that has taken place in the past five years. Chemical research in the industry is outlined on a panel which illustrates research in the laboratory and the use of petroleum derivatives for agricultural purposes.

As a final section of the exhibition, there are examples of the work of British manufacturers of oilfield equipment and a demonstration of the work of the Petroleum Information Bureau in the form of a display of leaflets and posters which discuss the various aspects of the industry.

Accompanying the exhibition three programmes of films are being shown daily under the auspices of the Petroleum Films Bureau, and in addition there is a special arrangement by which any film listed by the Bureau will be shown on request.

The oil companies are to be congratulated on a most interesting and informative exhibition, which not only well demonstrates the wide scope of the industry and the problems it is facing, but also serves to publicize the enterprise and achievements of British companies in the petroleum world.

C. A. FOTHERGILL

PROBLEMS OF THE NATIONALIZED INDUSTRIES OF GREAT BRITAIN

THE Acton Society Trust is issuing a series of papers in which an objective analysis of some of the problems of nationalized industry is attempted. The series* is edited by G. R. Taylor, and the first two pamphlets issued deal with "Accountability to Parliament" and with the "Powers of the Minister".

The first of these examines the reasons why Parliamentary control of the nationalized industries has not proved wholly satisfactory, and gives alternative or additional methods of supervision which might be employed. There is also appended an analysis of questions put in the House of Commons relating to the nationalized industries. Briefly, Parliamentary control has been unsatisfactory because the flow of information to Parliament is inadequate and behindhand, and because members, in general, have not proved capable of assessing the highly technical problems involved and of pointing out with unanimous voice what is wrong. For Parliament to function more effectively, more frequent debates would be necessary and also attainment of a higher level in the debates, while Parliament would require more detailed information on which to base its judgment. A second alternative would be to transfer some part of the burden to a body other than Parliament. The pamphlet points out, however, that the question whether the public corporation is the most satisfactory means of operating nationalized industry should not be prejudged: the form of industrial ownership most consistent with social justice and public accountability may be of a different character altogether. More radical thinking is required, and a satisfactory solution is likely to be difficult while the principal political parties are sharply divided on the issue of nationalization itself.

The second pamphlet, after summarizing the statutory powers which have been given to the Ministers responsible for the newly nationalized industries and examining the use which has been made of those powers, discusses the proper role of the Minister with the view of determining what those powers should be. The conclusion is reached that the very extensive, not to say absolute, powers which the Ministers possess have been used with extreme caution, but that the situation is unsatisfactory because Parliament has developed no clear idea of the Minister's functions or of how close its supervision of the nationalized industries should be. That must be the first step towards a definite solution; but the present powers of Ministers appear to be somewhat excessive, and urgent consideration of the dispersal of some part of the Minister's powers among other bodies or persons and, where this is impossible, of the establishment of checks or balances, is recommended.

Whatever powers are left to the Minister, adequate safeguards have still to be created against a possible abuse of power. Some alarm is expressed, in particular, at the Minister's power to prevent the disclosure of his own actions when, in his own opinion, it is not in the interests of security to do so, and surprise is expressed that any Parliament should have been prepared to assent to such a condition. The present situation, it is urged in this pamphlet, cannot be regarded with equanimity by those who are concerned with political freedom, even if the assumptions are made (none of which are above question) that industry must necessarily be operated on the national scale, that control must be largely centralized, that government itself must be highly centralized, and that commercial undertakings can best be supervised by a political body divided on party lines.

A third pamphlet in the same series, "Problems of Promotion Policy", brings out two grave dangers that procedures and policies in the nationalized industries present: first, the conflict between the desire for promotion by seniority and the need for a satisfactory standard of efficiency and service has not been faced; and secondly, there is a tendency to build up a rigid and elaborate system of regulations which both fails to secure justice and at the same time reduces efficiency and flexibility.

* Nationalized Industry Series: No. 1, Accountability to Parliament (pp. 33, 1950); No. 2, Powers of the Minister (pp. 20, 1951); No. 3, Problems of Promotion Policy (pp. 20, 1951). (Acton Society Trust, Acton House, Church Road, Claygate, Esher, Surrey.) 2s. each.

GOVERNMENT SOURCES OF SOCIAL AND ECONOMIC RESEARCH DATA

A REPORT from the Interdepartmental Committee on Social and Economic Research*, issued in December 1950, covers the work of the Committee to July 1950. Referring again to the increasing extent to which central government departments have become important sources of the raw material necessary for research in the social sciences, the report points out that the developments which have led to this position will assist the progress of knowledge only if the departments realize the importance of research to administration, are aware of the potential research value of much of the information which they collect, and able and willing to make reasonable provision for the needs of research when processing the material, and are prepared, subject to necessary safeguards of confidential material, to make such material available to research workers outside as well as inside the government service. Even confidential material should be released as soon as circumstances permit.

The Committee, noting the view expressed by the Select Committee on Estimates in a report for the 1946–47 session that "one of the weakest points in the Government machine . . . is the absence of sufficient provision for the identification of scientific problems in day-to-day administration", observes that, while the administrator who is concerned with solving day-to-day problems very rarely has time in which to enlist the aid of research in matters affecting current policy, there are at least two ways in which he can take thought for the future. He can try to foresee in advance the problems which need investigation, and he can provide for the scientific observation of what is now happening in order that lessons may be learned for the future. On this ground the Committee takes the view that government departments should be encouraged to do research themselves, especially by the application of existing techniques to the material they possess, and that, where they have insufficient material or staff for their purpose, the departments should approach the universities. It is important, too, that departments should be in touch with current research in their field, and the Interdepartmental Committee on Social and Economic Research suggests that they should consider how this can best be achieved and maintained.

Some departments already have well-organized liaison with outside research bodies, and the Committee is always ready to put departments and outside workers into touch with each other. As its work becomes more widely known, it expects to be used more frequently as a clearing-house between official and non-official interests. Already the Committee has helped to relate a project of the Social Research Division of the London School of Economics, involving a survey of certain aspects of occupational and social mobility, to the needs of the Ministry of Labour and National Service. As a result, the Social Survey of the Ministry of Information drew up a modified scheme, carried out the field-work and prepared two sets of punched cards; one set is in the hands of the Social Research Division of the School and the other has been retained by the Social Survey to prepare a report on those aspects of the inquiry in which the Ministry of Labour and National Service is particularly interested.

Since its last report, the Committee has surveyed the material available in the Ministry of Education and the Board of Trade. The first of these two surveys has been completed except in relation to the school medical service, and the sub-committee responsible for the survey considered very fully the kind of information required for the subjects of most importance to educational research at the present time. While the Committee supports the Ministry's view that every local education authority should maintain individual records of pupils in the schools in its area, it did not feel justified in recommending that at the present time the Ministry should attempt to collect centrally even a sample of such records. It suggested that more complete data about young workers might be obtained when the county colleges came into full operation, and supported the arrangement made by the Ministry of Labour and National Service and the Central Youth Employment Executive for obtaining an industrial analysis for first employment by age of entry, age of leaving school and broad occupational category. It also suggested that it would be helpful, as a measure of failure after leaving school, if the Ministry of Education consulted with the Home Office regarding the possibility of providing an analysis of the occupations and previous education of juvenile offenders. Certain recommendations made regarding the administrative statistics produced by the Ministry have been accepted.

To avoid delaying recommendations to the Board of Trade until the whole of the exceptionally large field has been covered, it has been arranged that the sub-committee should report at convenient stages. Recommendations already made to the Board based on three interim reports of the sub-committee include those arising from a detailed examination of the tabulation schemes for the Census of Production and the Census of Distribution, which endorsed *inter alia* the possibility envisaged by the Board of marrying data derived from each source about sales. Following the Committee's recommendations, the Board has agreed that in general there would be no objection to the publication of the results of research done within the Board of Trade, and examples of material thus made available are: publication in *The Times* of summaries of the results of research into changes in productivity, by Dr. L. Rostas; and the findings of an inquiry, by Mrs. K. H. Ross, into pre-war working-class clothing consumption, which has been published in the *Journal of the Royal Statistical Society*. Other recommendations have been made in the fields of insurance, companies and bankruptcy, the administration of enemy property and statistics. Particular attention is directed to the Patent Office, and, in view of the value of the material there, the Committee expresses the hope that it may be possible for information on the long-term trends in invention to be published in the *Board of Trade Journal* or elsewhere. Reviews of Patent Office experience, it suggests, would provide a very useful background and would stimulate interest in the possibility of research in the field which it covers. As examples, the Committee cites research into the relations between inventions and the trade-cycle or, on a sample basis, into the number of inventions which are not exploited and the reasons why they are not developed.

* Report of the Interdepartmental Committee on Social and Economic Research. (Cmd. 8091.) Pp. iv+14. (London: H.M. Stationery Office, 1950.) 6d. net.

Some concern has been expressed lest material of value to research is not being preserved for use in the future, and the Committee points out that statutory provision has been made for preserving, so far as possible, all important documents in the possession of government departments. Following acceptance by the Public Records Office of a recommendation made in the Committee's first report, the words "or useful for social and economic research" are being added to the appropriate clause in the departmental schedules. Effect is also being given to its recommendation for consultation between the Committee of Inspecting Officers of the Public Record Office and representatives of departments and academic experts. The Committee is also compiling from time to time lists of unpublished documents which departments are prepared to make available to research libraries and is circulating them to some sixty university and other such libraries; four such lists have already been circulated. Advice is being given by the Committee on the modification of existing, or introduction of new, statistical tables, and it is also considering the question of the presentation of social statistics for conurbations where single administrative units provide an unsatisfactory basis.

THE FILM IN FUNDAMENTAL EDUCATION

THE actual and potential use of the film as a medium in the education of illiterate peoples has recently been described by Peter Brinson (Film Discussion Groups in Fundamental Education, Film Centre, Ltd., 1950; 1*s*.).

Film discussion groups have been formed in India, Indonesia, China, Mexico, South American countries and various non-self-governing territories of the world. In Brazil, five hundred of the 1,500 projectors distributed during 1949 as part of the radio and cinema service of the Ministry of Health were kerosene-operated projectors for use in rural areas without electricity. Here film shows and radio broadcasts through community listening posts are beginning to provide both the opportunity and the means of starting discussion groups as an additional method of instruction at the disposal of the teacher and as an important link between the film-maker and his audience.

An example of the way films are being, and might be, used in fundamental education at the local level is seen in the territory of the Egba Native Administration in the Western Province of Nigeria.

Excluding Lagos, Nigeria is ruled indirectly through native administrations, having their own treasury, courts, prisons and police, markets, sanitary services and the like. District heads and village heads complete the chain of responsibility. Egba includes within its boundaries about twelve thousand people living in eleven villages around the principal city, Abeokuta. The people are mostly peasants, and 80 per cent are illiterate. There are a number of endemic diseases such as tuberculosis and malaria, public hygiene generally being an urgent concern. Nigeria as a whole is large, equal in land area to France and Italy together, with a total population of thirty million. Relative to its size it is sparsely inhabited, distance and communications constituting one of the key factors in development.

The problems which the area raises are fairly typical of fundamental education areas generally. The people of Egba belong to the Yoruba language group, one of the four main groups in Nigeria, which is the basic language for approximately four million people.

In Lagos, the main administrative centre for Nigeria, there is a Government film production unit which was established in 1950, and which is now beginning to make films for use throughout the country. The administration makes use of films from outside, particularly the productions of the Colonial Film Unit in London. There is, too, a mobile projection service, so far on a restricted scale. In 1948, the number of Government 16-mm. mobile cinema vans in use in Nigeria was reported to be four; it seems unlikely that the total number of projectors available for use in mass education exceeds twenty. Each Government van goes on tour for 3–4 months, visiting fifty to sixty towns and villages on each circuit, giving exhibitions to about a hundred thousand people. The average attendance at each show in Nigeria numbers about two thousand persons. In the case of the Egba native administration, a mobile cinema van visits the area once every six to nine months.

There are no Government schools in the area; but four native schools and twelve missionary schools provide primary education. Although adult education centres have recently been set up in different parts of Nigeria as part of special mass education campaigns, they have not so far been established in Egba. There are, however, additional institutions within the area which are of value in mass education generally, and might also be of particular value for using the film in conjunction with discussion groups. There are a hospital at Abeokuta and dispensaries in most of the larger villages. In nearly all the larger villages, too, there is a church. The people of the area meet to sell their produce at about fourteen marketing points, and there is one farmers' co-operative, totalling 700–800 people, and mostly made up of the richer members of the community. These places—the school, the church, the market place, the dispensary—which are popular meeting places, provide the functional centres on which education and an educational film service can be developed according to the people's interests.

The amount of educational work which can be conducted in the area through films and radio is small. With relatively few receiving sets and a mobile film van visiting the area only once every 6–9 months, the opportunity for conducting experiment or even for building up a concentration of interest around a particular problem, such as farm practice, or public hygiene, is limited. The immediate necessity for film-maker and for educationist is clearly to increase the equipment available. The problem is finance; 16-mm. projector units are relatively expensive items of equipment, and the Government must take into account competing claims on public funds. It may be possible, however, for the native administration itself, out of its own treasury, to purchase its own projector to supplement the work of Government units. The farm co-operative may be in a position to assist; private resource could supplement official activity. Although there are few instructors and discussion group leaders, there is a nucleus of people in the community, among the village school teachers—both certificated and uncertificated—the leading members of the co-operative,

and the people in charge of the village dispensaries, from whom the kind of person to organize and lead discussions after a film show or broadcast might be recruited.

With the help of higher educational institutions, of teachers' training colleges and, in the case of Nigeria, of the National Union of Teachers, a special course might be started on discussion group techniques and the use of visual aids. To this course could come both certificated and uncertificated teachers. A simpler course could be run for volunteers who may not be teachers but who are willing and able to act as discussion group leaders in their own localities. Official help is needed for the training of projectionists.

Once a nucleus of people is trained in using films or broadcasts as a stimulus to discussion, on their return to their particular community or village they could attempt to pass on what they have learned to additional small groups, later advising the film-makers and educators of their experiences.

FORESTRY IN NIGERIA AND THE GOLD COAST

ANNUAL REPORTS FOR THE YEAR 1948–49

THE reports of the Forest Departments of Nigeria* and of the Gold Coast† both mention some progress made in forest management during the year 1948–49. The Nigerian report states that there has been a surge of development in Nigeria as a whole, from the commercial, administrative and political points of view, and this has to some extent overshadowed forestry progress. It is stated that the dispersal of experienced men at all levels, which is the inevitable consequence of rapid expansion of staff, has not been the least of the problems. It is difficult to understand what is meant by this, since Nigeria has for so long been notorious for the shortness of forestry staff compared with the size of the country and the size of the areas to be put under a much more intense management. From the experience gained at universities in Great Britain, Nigeria would appear to have been somewhat hasty in the initiation of higher training for African officer staff at the new University College at Ibadan.

As to the strength of the gazetted staff, it is now fifty-six, having risen from forty-five, and this is not a very great increase for such a big important forestry country, since the staff was at least fifty in 1934. There is no doubt that the liaison between members of the House of Assembly and the Department of Forestry should be all to the good.

The forestry policy of the whole of the country, especially of the northern region, is badly in arrears. The concentration of the staff where the revenue can be made has not been in the interest of the northern populations, which probably require the attentions of the forester quite as much as the more revenue-producing areas. This neglect of the north is one reason for the very low numbers of the executive staff which have been maintained for so long in the Nigerian Forest Department, and yet it has just been learned in Great Britain that seven forestry appointments which were to have been made in Nigeria have been withdrawn at the instance, presumably, of the exigencies of finance. For rural planning and developments, so far as forestry and agriculture are concerned, a strong cadre of fully trained forest officers will prove indispensable.

In the introductory remarks to the report for the Gold Coast, it is stated that a new and detailed forest policy formulated in 1946 has now been formally approved by the Governor in Council. There is not very much new in these statements of policy that has not appeared over and over again in the reports and government statements for all of the Colonial Services in which there is a forest department; but in many of them it has not yet achieved a very wide success. More especially is this so in connexion with the aim so often enumerated of the forest policy: "management of permanent forest resources by methods that will achieve maximum productivity and value on the basis of a sustained yield". If back-numbers of various annual forestry reports are consulted, it becomes easily apparent that these Colonies are very far from having achieved this policy.

The Gold Coast report goes on to discuss the progress in the execution of the policy made. One important point in connexion with this introduction and maintenance of the sustained yield is disclosed by the statements that considerable progress has been made in stocktaking in forest reserves, but that there is still a considerable programme ahead. To the forester this at once discloses the position of the Colony and how far behind it is in this matter after thirty to forty years of a Forest Department.

A point of real interest is the native administration forestry under which native authorities are encouraged to manage and develop their forest reserves, and new rules give them opportunities to do so. As might have been expected from practices of the past, starting a century or so ago in India, little progress has been made by Native Authorities in the provision of land for fuel plantations. One of the reserves is being steadily developed as a demonstration area for this purpose. It is interesting to note that in the Northern Territories, which a few years ago were almost entirely neglected by the Forest Department, nine proposed reserves are to be made, and there will be some interesting forestry work undertaken in the future if the present policy in connexion with the Northern Territories is really given effect.

During the year an inter-Colonial conference in forestry and other questions was held in Accra under the chairmanship of the Chief Secretary of the West African Council. The first part of the conference discussed general forestry questions and was attended by Mr. W. A. Robertson, technical adviser to the Secretary of State in Forestry, and by the chief conservators of forestry of Nigeria, the Gold Coast and Sierra Leone. The second part discussed timber utilization and was attended by the general manager of the railways, representatives of the Public Works Department, and representatives of the timber trade, Nigeria and the Gold Coast.

It is apparent from this Gold Coast report that there is now much closer co-operation between forestry and the Departments of Agriculture, Animal Health and Customs.

* Nigeria. Annual Report on the Forest Administration of Nigeria for the Year 1948–49. Pp. 59. (Lagos: Government Printer; London: Crown Agents for the Colonies, 1950.)

† Gold Coast Colony. Report on the Forest Department for the Year 1948–49. Pp. 22. (Accra: Government Printing Department; London: Crown Agents for the Colonies, 1949.) 2s.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Synthesis of Nucleoprotein in Bean Root Cells

THE autoradiograph technique permits the presence of a radioactive isotope to be detected in individual cells and cell parts. It thus becomes possible to study the time of synthesis of a compound by providing the cell with an isotope of a suitable element, and, after fixation, dissolving out all other compounds which contain this element. This method has been applied[1] to the uptake of phosphorus-32 by nuclei of *Vicia faba* root cells, by growing roots in a solution of sodium dihydrogen phosphate and treating the fixed tissue with acetic acid - alcohol, water and *N* hydrochloric acid at 60° C. Squash preparations then show nuclear autoradiographs above some cells; that is, cell nuclei contain phosphorus-32 in the form of a compound which is not removed by these reagents. From a study of the percentage of resting nuclei which show autoradiographs after different periods of growth with phosphorus-32, and their distribution in the length of the root, and from the delay in the appearance of an autoradiograph over dividing nuclei, it was concluded that: (1) the phosphorus compound is not synthesized during cell division, nor during the period immediately preceding it, but during some part of interphase; (2) it is synthesized in cells which are preparing for division, but not in cells which will differentiate without further division; (3) phosphorus-32 in the form of this compound remains in nuclei for considerable periods of time and is transmitted to daughter nuclei.

Recent experiments in which root cells were exposed to deoxyribonuclease have shown that this enzyme removes the compound which gives rise to the nuclear autoradiograph, and we may therefore conclude that the presence of such an autoradiograph is due to the synthesis of deoxyribonucleic acid within the period of treatment with phosphorus-32.

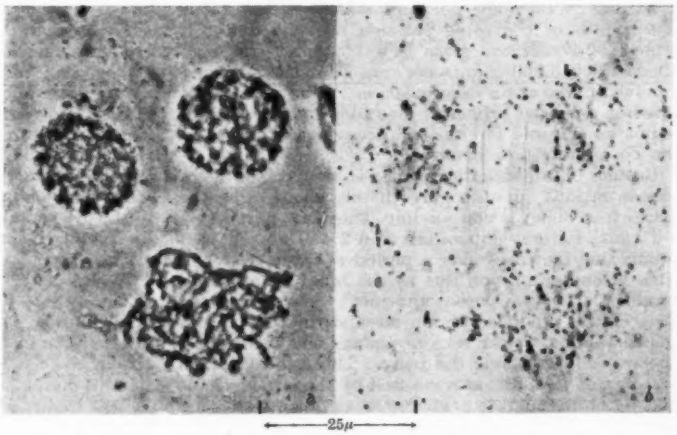
Deoxyribonucleic acid apparently does not exist as a free molecule in the cell nucleus, but is to be regarded as a more-or-less firmly bound part of the nucleoprotein entity. The protein part of this entity is not necessarily synthesized at the same time as the nucleic acid, and it seemed of interest to compare the two parts in this respect. The simplest possibility of labelling the protein part seemed to be by the use of radioactive sulphur. Using sulphur-35, which decays with a half-life of 87 days and emits β-rays of 0·11 MeV. maximum energy, autoradiographs can be obtained with a lower radiation dose to the tissues concerned than is possible with phosphorus-32. This was an additional factor in making sulphur-labelled protein desirable. Although no radiation damage was observed when the growth-rate of bean roots grown with phosphorus-32 for autoradiographs was compared with roots grown without phosphorus-32, attempts to extend the experiments to mouse tumours showed that the concentration of phosphorus-32 necessary to produce autoradiographs in this tissue would cause appreciable radiation damage.

Bean roots were grown for 20 hr. in a solution containing 1 μC./ml. of sulphur-35 in the form of sodium sulphate, and autoradiographs prepared in the same way as with phosphorus-32. Squashes show autoradiographs above cytoplasm and nucleus with a resolving power of approximately 1–1·5 μ. The autoradiographs above the cytoplasm are heavier near, and above, the cell wall than in the centre, and are much heavier above meristematic cells than above elongated cells. Many round resting nuclei and chromosomes removed from their cells during squashing show autoradiographs (see photograph). The nuclei of elongated cells usually show no autoradiograph.

ROOTS OF *Vicia faba* GROWN FOR 20 HR. IN PHOSPHORUS-32 and SULPHUR-35 (SQUASH PREPARATIONS)

	% cells showing nuclear autoradiograph			
	Meristematic cells not in division	Elongated resting cells	Round resting nuclei in squash preparations free from cytoplasm	Cells in division
^{35}S	76	29	68	94
^{32}P	80	13	61	92

It can be assumed that all inorganic compounds containing sulphur-35 were removed during the fixation, washing and especially hydrolysis, and that most of the remaining sulphur-35 is bound in protein and especially nucleoprotein, where the autoradiograph shows it to be in resting and dividing nuclei. The percentage of cells showing a nuclear autoradiograph after 20-hr. treatment with phosphorus-32 and sulphur-35 is given in the accompanying table. The similarity in the figures indicates that both elements are incorporated during the same period of cell division. The different uptake in different types of cells makes it likely that the autoradiographs are due to sulphur-35 incorporated in organic compounds which are synthesized in connexion with cell division. If the radioactive sulphur had been incorporated in



Autoradiographs of squashes of bean root tips. (1 μC./ml. sulphur-35 for 20 hr. Exposure, 74 days.) (*a*) phase contrast (*b*) same field as (*a*), no phase contrast

compounds in exchange for stable sulphur, the older elongated cells should show heavier uptake than the younger dividing cells. The table shows that the reverse is the case, and exchange processes can therefore be only of minor importance.

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Jan. 22.

[1] Howard, Alma, and Pelc, S. R., *J. Exp. Cell. Res.* (In the press).

Measurement of Radioactivity in Human Breath

The breath from patients with radium or thorium in their bodies shows considerable radioactivity. Breath measurements are a useful indication of the type and amount of internal radioactive contamination. In this Laboratory, α-activity has been measured by two methods, both using apparatus supplied by the Atomic Energy Research Establishment, Harwell.

The first uses the α-radiation breath-monitor, type A.E.R.E. 1056*A*. A four-litre specimen of the patient's exhaled breath is collected and drawn into an evacuated ionization chamber; the α-disintegrations in this sample are then counted.

The second method permits continuous-flow measurements and has been developed here. The patient breathes normally, inhaling each time through the nose and exhaling orally through a drying tube and a flow counter, in which the exhaled air is the counter gas. Each α-disintegration in the air temporarily within the flow counter causes ionization and consequently a voltage pulse on the counter anode. This is amplified and counted.

The two types of breath counter have been used for thoron-counting and a little radon work also. Sixteen patients with internal thorium-contamination have been investigated, and all have thoron activity in the breath. With the continuous-flow apparatus they give counting-rates from about 30 to 100 counts per min., so that five minutes of breathing gives a few per cent statistical accuracy. The breath of the same patients measured on the type 1056*A* monitor gives initial counting-rates of about 1,000–3,000 counts per min., but these figures involve an uncertain extrapolation. Thus the 1056*A*, which is designed primarily for radon measurements, is not so suitable for quickly decaying activities as the continuous-flow counter.

Results obtained indicate that these patients have concentrations in the breath of about 100–300 μμC./litre. The corresponding thorium burden is 2–10 gm., initially equivalent to 0·2–1·0 μC. Thoron production increases over a period of years from the time of contamination due to the build-up of decay products from the parent thorium; at most, 1 per cent of the produced thoron escapes in the breath, the remaining 99 per cent producing the subsequent decay products inside the body. The radioactivities of different patients, as measured by the two methods and by quite separate β- and γ-measurements on other parts of the body, agree satisfactorily.

For comparison with the thoron results above, the radium–radon tolerance figures are as follows: 40 per cent of the total emanation produced from 0·1 μgm. radium fixed in the body escapes in the breath, giving the accepted tolerance dose 1 μμC./litre of breath, which corresponds to about $\frac{1}{3}$ count per min. in the flow counter, and an initial counting-rate of about 9 counts per min. in the type 1056*A* breath monitor.

Details of the continuous-flow counter are as follows. The drying tube consists of the standard magnesium perchlorate anhydrone flakes in a column 10 cm. long × 4 cm. in diameter. The counter is the A.E.R.E. 'methane counter' type 1077, with volume 135 ml., a heavy brass cathode 14 cm. long × 3·2 cm. in diameter, and tungsten anode 11 cm. long × 0·01 mm. in diameter. It is operated with anode at + 2,000 volts, from a well-stabilized power supply. This gives small gas-amplification, absolute efficiency of *c.* 60 per cent, background 2 counts per min. and plateau slope 0·7 per cent per volt. To assist the patient to breathe out through the apparatus, the inlet hole is enlarged and a water suction pump attached to the outlet. The amplifier is type 1049*A*, the flow counter fitting directly to the head amplifier. Full gain of 16,000 is used, and the output pulses from the amplifier are taken to a scaler, type 1009*A*, working at 5 volts bias, 1 millisec. paralysis time.

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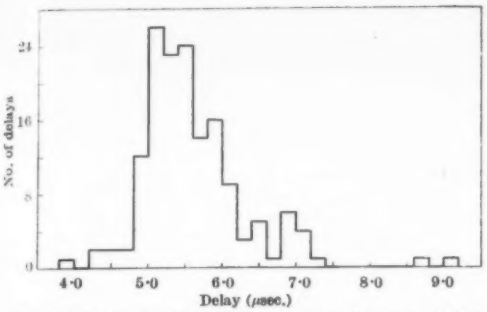
Time-delays in Low-voltage Halogen-quenched Geiger–Müller Counters

Low-voltage halogen-quenched Geiger–Müller counters find increasing applications in many fields, especially for use in portable survey and assay instruments[1]. Their chief advantages are: (i) very low temperature coefficient down to − 50° C.; (ii) very long counting life; (iii) extreme electrical robustness; (iv) simple battery requirements; (v) large output pulse necessitating no pre-amplification.

These characteristics would greatly simplify the problems associated with Geiger–Müller counters arranged in multiple coincidence circuits, as often occurs in cosmic-ray research, provided that no other difficulties were introduced. One important possibility which would limit the use of halogen-quenched counters would be long time-delays between passage of the primary ionizing particle and development of the output pulse. This would be due, if it occurs, to the low mobility of negative ions formed in gaseous bromine and chlorine, which have high values of electron attachment coefficient.

Accordingly, work is in progress in this laboratory to investigate any time-delays and their dependence on counter parameters. The first results were obtained from a counter constructed of chrome-iron foil in a glass envelope; the centre wire was 0·12 mm. in diameter and its effective length was 195 mm. It was mounted between two argon-alcohol counters of 20 mm. diameter forming a simple cosmic-ray coincidence telescope, the axes being parallel and vertically above each other.



Time-delays in halogen counter: diameter, 25 mm.; working voltage, 390 V.; anode diameter, 0·1 mm. Approximate pressures of gases used in counter: neon, 200 mm.; argon, 0·2 mm.; bromine, 0·16 mm.

The coincidence pulse occurs at a time after the initiating event which is a function of any time-delays in the alcohol-quenched counters. This uncertainty is known to be of order 0·25 microsec. for the type of counter used[3] (9 cm. argon + 1 cm. alcohol filling). The coincidence pulse triggered an oscilloscope time-base[3], and then it and the pulse from the bromine counter were delayed, displayed along the time-base and photographed. A time-scale was provided by 1-microsec. marker pulses, and delays were thus measured directly, as shown in the accompanying diagram.

The angular resolution of this system was very poor, as is shown by the asymmetric distribution; but it was thought worth while to report early results. It will be seen that the mean delay is 5·3 microsec., rising to a maximum value of 9·3 microsec.; no delay less than 3·5 microsec. was observed in two hundred events.

Experiments are continuing in greater detail to decide whether this time-delay represents a true 'transit lag', or whether it is in part due to a decreased rate of spread of discharge.

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Adsorption of Water Vapour on Solid Surfaces

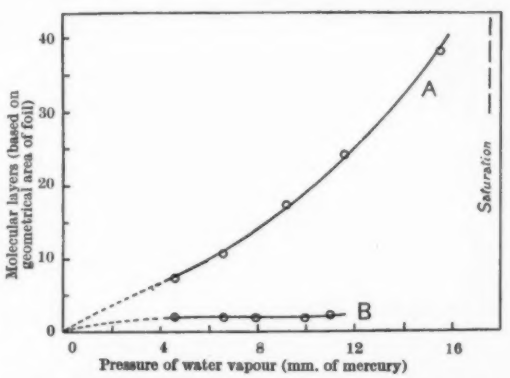
It has been reported[1,2] that the adsorption of water vapour on metal surfaces at high relative humidities is very heavy and corresponds to layers more than 100 A. in thickness. There are numerous similar references to the adsorption of water on glass from Faraday (1830) to Veith (1944). Much of the work is vitiated by uncertainty about the true surface area of the adsorbent, and the work of Razouk and Salem[3] indicates that the adsorbed layer on glass does not extend to more than a few molecules in depth at high relative humidities. A comprehensive review of the evidence in favour of 'long-range' surface effects has recently been given by Henniker[4]. Much of the work quoted suggests that water and other pure liquids in contact with solid surfaces possess a high viscosity or a 'rigidity' which is induced by the surfaces and which extends to a distance of many hundreds or even thousands of angstroms.

It is difficult, on general grounds, to account for these effects, and much of the evidence is open to criticism. Measurements of the viscosity of thin films of water, of alcohol and of other liquids enclosed between flat surfaces of metal and of glass (Bastow and Bowden[5]), have shown that the liquid films obey Poiseuille's Law, and their viscosity is normal down to a thickness which is limited only by the degree of polish of the surfaces. It is only when the liquids contain a small amount of dissolved impurity, such as ammonium oleate, that anomalous viscosities are observed. Courtney-Pratt[6], working in this Laboratory, has made a direct optical measurement of the thickness of the film left behind on a mica surface by the retraction of a drop of liquid stearic acid and has shown that it is uni-molecular.

We have recently measured the adsorption of water vapour on metal surfaces using as direct a method as possible. This was done by measuring on a microbalance the increase in weight of metal foils when water vapour was admitted. The results suggest that the heavy adsorption is spurious and is due to contaminants on the surface. Foils of gold and of platinum cleaned by degreasing solvents do not always exhibit it. When heavy adsorption does occur, it can be eliminated by drastic heating of the metal during the preliminary evacuation.

Curve *A* shows the adsorption on 20 sq. cm. of platinum foil cleaned but not specially heated. Curve *B* shows the adsorption of water on the same piece after it had been raised to a red heat by electronic bombardment, and allowed to cool *in vacuo* while suspended on the balance.

It is not clear what the impurities are; but quite a small amount (of the order of 10^{-7} gm./cm.^{2}) of a hygroscopic salt would suffice to account for the adsorption on curve *A*. It is presumed that the heating *in vacuo* expels this from the surface. A number of other experiments on platinum and gold surfaces which had been heated gave similar results in that no heavy adsorption was observed, even when the pressure of water vapour was 90–95 per cent of saturation. Curve *B* does not appear to be of the sigmoid shape which is usually found for



Adsorption of water vapour on platinum foil; temperature 20° C.

adsorption on a free surface. It resembles, rather, the results of Kemball[7], who found from surface-tension measurements that the adsorption of water vapour on a liquid mercury surface did not extend beyond a monolayer at 95 per cent saturation.

Confirmatory experiments were carried out using the elliptical polarization of light to measure the thickness of water films adsorbed on metal, on diamond and on zinc blende surfaces. Again, no evidence was found for heavy adsorption even when the vapour was 90 per cent saturated. The adsorbed layer was at most a few molecular layers in thickness.

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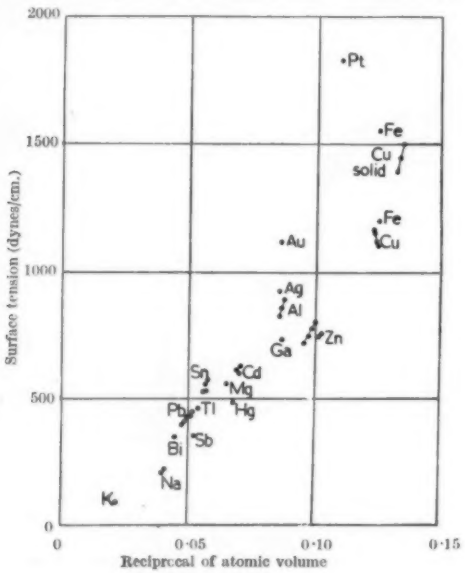
Surface Tension of Liquid Metals

When the available experimental values of the surface tensions of liquid metals are plotted against the reciprocals of the corresponding atomic volumes, the accompanying diagram is obtained. The surface tensions are not known with high accuracy; but it is clear that surface tension is approximately inversely proportional to atomic volume, and that the relationship holds for metals of such widely different types as sodium, bismuth and iron.

There seems as yet no satisfactory theory of the relationship—the early calculation of Frenkel[1], in which it is implicit, has been shown to be incorrect[2]—but two empirical implications are of interest. First, the surface tension of any metal for which experimental surface tension data are unavailable can be approximately assessed from density measurements with an accuracy probably little inferior to that which can at present be obtained by surface tension experiments. Secondly, we have recently shown experimentally, in connexion with metal penetration into compacted sand during sand-casting[3], that the height of metal that will stand on a sand compact without penetrating into the capillary pores is proportional to surface tension/density and inversely proportional to the effective pore radius; the present relationship coupled with this result leads to the very simple conclusion that the height of metal that will stand on a given sand compact is approximately inversely proportional to atomic weight alone, and that for a sand compact to resist penetration by a particular height of metal, the effective pore radius must be inversely proportional to atomic weight. This may be a matter of importance in the production of sand-castings of metals of high atomic weight.



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Colour of Beryl

The colour of bright emerald-green was first attributed to chromium by Vauquelin[1]; this was questioned by later observers, who found that the emerald lost its chromium content upon ignition, but retained its colour. Borovik[2] has recently observed that a white mixture of 0·4 gm. of powdered beryl and 0·02 gm. of scandium oxide gradually becomes dark blue, and concludes that scandium penetrates "into the beryl as deep as its crystal lattice and is responsible for its colour".

On this point, I have analysed spectrographically (by cathode layer arc) seven Indian beryls of different colours—pale red, orange-yellow, apple-green, pale greenish-blue, sapphire-blue, pale blue and bluish-white—and found only in one variety a concentration of scandium of the order of 10^{-3} to 10^{-4} per cent. The complete absence of scandium (limit of detection 10^{-5} per cent) in the six colour types indicates that scandium is not the cause of coloration in beryls. In all the beryls, alkalis are present in traces: rare-earths have been detected only in four varieties.

The colour of such minerals seems to be a phenomenon connected with the crystal distortion due to a combination of factors, which are perhaps affected by impurities. But the fact that the changes of colour of pale blue beryl to light green and of white beryl to pale brown can be produced after long X-ray irradiation suggests that the phenomenon is not simply due to traces of impurities.

Thanks are due to Prof. P. B. Sarkar and Dr. J. W. Whitaker for their interest in the work, and to Dr. W. D. West for kindly supplying the samples.

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Bacteriophages carried by the *Vi*-Phage Types of *Salmonella typhi*

As the result of work aimed at the clarification of the relationship between *Vi*-phage types *F*1 and *F*2 of *Salmonella typhi*, it has been found that type *F*1 appears in clones in old cultures of type *F*2 maintained at room temperature. When the two types are grown together, type *F*1 is rapidly eliminated and the culture becomes pure type *F*2 once more. The explanation of this phenomenon was found when it was discovered that *F*2 normally carries a phage to which *F*1 is highly susceptible. We have designated this phage '*f*2'. Type *F*1, which is not lysogenic, is lysed by phage *f*2 and is also converted by it into type *F*2, simultaneously becoming lysogenic. The *F*1 variant makes its appearance in old cultures of *F*2 when some of the organisms lose this phage.

The demonstration that phage-free organisms can appear in a lysogenic culture is of considerable interest, and runs contrary to the generally accepted view that lysogenicity is a permanent character of a given strain[1-3]. The detection of the phage-free variant is made possible by the *Vi*-typing phages[4].

A number of *Vi*-phage types of *Salm. typhi* were found to be susceptible to phage *f*2; a few of these were treated with it and the resistant organisms resulting from this manipulation were tested with the *Vi*-typing phages. The findings are listed below:

Vi-phage types of *Salm. typhi* treated with phage *f*2

Original *Vi*-phage type treated	*Vi*-phage type of secondary (resistant) growth
A	29 (Borman)
*D*1	*D*6
*D*4	Untypable *Vi* strain
*E*1	A new subtype of the *E* group
*F*1	*F*2

It was found that, in broth cultures of these types exposed to phage *f*2, the phage titre rose to a critical level associated with massive lysis of the organisms. This phase was succeeded by one in which the titre of the supernatant broth dropped sharply, to reach an apparently constant and much reduced level as the resistant organisms of the changed type were evolved. These resistant organisms showed no signs of contamination with phage *f*2, but conformed in all respects to the criteria of 'lysogenic' cultures.

A search for phages carried by other *Vi*-phage types of the typhoid bacillus revealed that such phages were present in the supernatants of broth cultures of types *B*3, *D*1, *D*4, *D*6, *K*, *T*, 25, 26, 28 and 29. These phages have been designated phages *b*3, *d*1, *d*4, *d*6, *k* and *t*; the last four have not yet been named. Up to the present, therefore, eleven of the twenty-nine recognized *Vi*-phage types and subtypes of the typhoid bacillus[5] have been found to be lysogenic.

Using phages *d*1, *d*4, *d*6 and *t* in the same way as phage *f*2 for treating susceptible *Vi*-phage types of *Salm. typhi*, the following changes in type reactions have been effected in cultures of type *A*.

Original *Vi*-phage type	Treated with phage	*Vi*-phage type of secondary (resistant) growth
A	*d*1	*D*1
	*d*4	*D*1 (imperfect)
	*d*6	*D*6
	t	*T* (imperfect)

Simultaneously with the changes in reactions to the adapted *Vi*-phages, there occurred also changes in susceptibility to unadapted *Vi*-phages and even to anti-*O* phages. In all cases the resistant cultures have so far been found to remain phage-bearing. Work is proceeding along these lines, and details will be published in full elsewhere.

There seems to be little reason for doubting that *Vi*-phage type specificity in *Salm. typhi* is determined by a resistance pattern evolved in strains of the organism as the result of contact with phages. These phages are difficult to obtain free from their parent organisms, many being heat-labile and showing heavy losses on filtration. As a rule, they form extremely small plaques which are only detectable with a 10 × hand lens. Moreover, they show a considerable degree of susceptibility to minor variations in cultural environment and may be incapable of producing lysis on some batches of agar medium. Nevertheless, it is believed that it may be possible to isolate type-changing phages from other *Vi*-phage types of the typhoid bacillus.

It must be pointed out that Craigie[6,7] first isolated a phage from type *D*1, and, by infecting types *A* and *E*1 with it, converted them into type *D*1. We have confirmed this observation with type *A*.

Although the type transformation just described can be carried out under laboratory conditions, it seems unlikely that the *Vi*-phage types of *Salm. typhi* are constantly undergoing such changes in Nature. Indeed, the remarkable epidemiological constancy of the types indigenous to various countries, and to different areas of the same country, suggests that type transformations are exceptional under natural conditions.

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Central Respiratory Spike Potentials

The exposed medulla oblongata of the dog, cat and rat was explored by means of a stereotaxic instrument carrying a unipolar steel needle electrode (diameters from 10 to 40 microns at the non-insulated tip), and fast potential changes were recorded with amplifier and cathode-ray oscillograph. Simultaneous records were taken either (1) of respiratory movements using a strain-gauge, or (2) of tidal air using an electrically recording spirometer, or (3) of the action potentials of diaphragmatic muscle units. Method (3) shows the time relations between central and peripheral events more accurately, and at the same time allows the frequencies of the medullary and spinal discharges to be compared.

Active loci in the posterior floor of the 4th ventricle are sparse and few under anæsthesia (pentothal or

urethane) or after decerebration (in the rat), as also found by Gesell, Bricker and Magee[1]. Also in agreement with their observations, the respiratory discharges did not show the definite separation into inspiratory and expiratory regions which has been obtained on stimulation[2-5]; inspiratory discharges, however, seemed concentrated on ventral levels of the caudal median reticular formation of the rhombencephalon.

The records secured, especially with dogs, show that the inspiratory activity of single cells of the reticular formation consists of periodic bursts of 15–25 spikes (up to 200 μV.) with maximum frequencies of 50–90 per sec. (Figs. 1 and 3). Onset and subsidence are often gradual but sometimes rather abrupt. Similar features are seen in the bursts of spikes of diaphragmatic muscle units, but the maximum frequency is distinctly less than, and apparently independent of, that of the medullary discharge (Fig. 2). The central rhythmicity is unrelated to circulatory changes conducive to displacement of the medulla relative to the electrode as shown by the absence of any correlation with the electrocardiogram often visible in the diaphragmatic trace (Fig. 3).

The scarcity of respiratory potentials in the reticular formation of the medulla suggests that generally this structure does not function as a whole but only in parts. It seems to act as a trigger, periodically firing spinal, phylogenetically older, neuronal aggregates which are ultimately responsible for the co-ordinated respiratory movements[6,9].

The lack of complete dissociation of inspiratory and expiratory cells in the reticular formation encountered in the detection of electrical activity is in contrast with the apparent delimitation of well-defined inspiratory and expiratory regions on electrical stimulation. In the first case, the electrode employed in these experiments recorded from naturally active dispersed nerve cells occupying a volume not larger than 5×10^{-3} mm.^{3}, while in the second case the electrodes affected a volume of 0·5 mm.^{3} on optimum stimulation yielding maximum responses. Here the excitation of a great majority of one type will swamp that of a small minority of the other type of cells and, in fact, inhibit reciprocally the rest of the antagonistic type, while the excitation obviously spreads to other cells of identical type so that the net effect appears to be uniform.

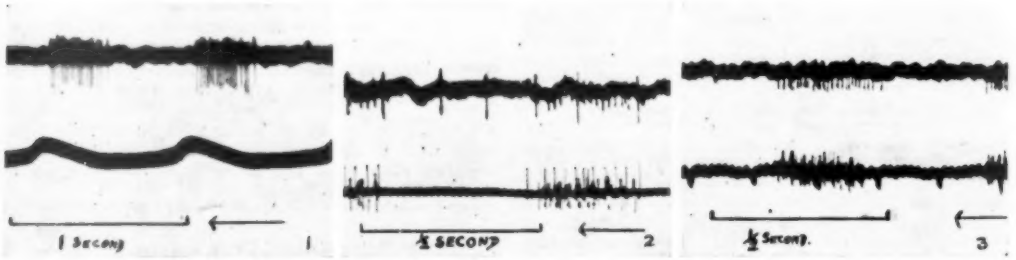

Fig. 1. Greyhound, spontaneous breathing, 71/min. Electrode tip, 0·5 mm. rostral to obex, 2·5 mm. lateral to midline, 3·5 mm. below surface. Inspiratory discharges of one cell (maximum rate, 55/sec.): fairly rapid onset, abrupt fall. Strain-gauge recording of chest movements

Fig. 2. Hooded rat, spontaneous breathing, 83/min. Electrode tip 1 mm. caudal to obex, 0·1 mm. lateral to midline, 0·2 mm. below surface. Inspiratory discharge: slow onset, one neuron (maximum frequency, 56/sec.) with occasional activation of another. Diaphragmatic discharge: one muscle unit of maximum frequency, 35/sec.

Fig. 3. Hooded rat, spontaneous breathing, 97/min. Electrode tip 0·8 mm. caudal to obex, 0·4 mm. lateral to midline, 1·7 mm. below surface. Inspiratory discharge: slow beginning, fast ending; initially one neuron (maximum frequency, 35/sec.), later one or two recruited. Long latency (about 50 m.sec.) of diaphragmatic volley. Note electrocardiogram in bottom trace (heart-rate 342/min.)

Rapid evanescent bursts followed by permanent silence indicate that the membrane of a single nerve cell had been pierced by the electrode tip[6]. When, however, the tip just misses the nerve cell, the periodic discharges recorded may disappear within a distance of 0·1 mm. and re-appear on raising the tip to the original level.

Central expiratory discharges are similar in character, but usually the maximum frequencies are appreciably lower. The frequency relation between inspiratory and expiratory bursts, however, is not fixed in all cases. The inspiratory frequency may be markedly slower than the expiratory frequency.

The central inspiratory discharge clearly precedes the muscular electrical bursts (Fig. 3), that is, the medullary inspiratory spikes are not produced by the arrival of afferent impulses. This is substantiated by the observation that, when muscular contractions have ceased after intravenous injection of D-tubocurarine, the inspiratory discharges continue and, owing to lack of oxygen and accumulation of carbon dioxide, increase in rate per min., in length and in number of neurons activated[7]. Afferent and efferent expiratory and inspiratory volleys have been found in the dorsal layers slightly caudal to the obex of the 4th ventricle (Fig. 2).

This work was aded by grants from the Scientific Investigations Grant-in-Aid, Royal Society (H. R.), and from the Central Research Funds, University of London (F. R. B., H. R.).

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A Soluble Protein derived from Elastin

During an investigation of the early stages of hydrolysis of various mucoids and connective-tissue proteins, it was observed that, on partial hydrolysis with acetic acid or oxalic acid at 100°, aspartic acid was in each case the first amino-acid to appear in the free condition, followed at a somewhat later stage by glutamic acid[1]. Since elastin has an unusually low content of the dicarboxylic amino-acids[2], it was thought that, with this protein, hydrolytic cleavage at some proportion of the aspartic or glutamic acid residues might yield soluble degradation products of high molecular weight.

Experiment showed that on extracting collagen-free elastin (prepared from ligamentum nuchæ of cattle) with 0·25 *M* oxalic acid at 100° C. for periods of 1 hr., the whole of the material passed into solution after five or six successive extractions. Removal of the oxalic acid from the mixed extracts by dialysis through 'Cellophane' resulted in the loss of about 5 per cent of the nitrogen as small peptides. Paper chromatograms carried out with the diffusible fraction showed aspartic acid as the only free amino-acid; but since pyrrolidone carboxylic acid (in which form glutamic acid might be found) gives no reaction with ninhydrin, the presence of this compound in low concentration could not be excluded.

The non-diffusible protein was soluble in water at temperatures below 25° C., giving a pale yellow mobile solution. On raising the temperature to 25–30° C. in the presence of dilute buffer (*p*H 4–6), a precipitate consisting of liquid droplets separated. The droplets showed no birefringence under crossed nicols and immediately redissolved on reducing the temperature. On centrifuging at 37° C. the droplets coalesced to form a lower layer of viscous liquid; refractive index measurements showed the two liquid phases to consist of aqueous protein solutions of different concentration.

When dialysed against buffer mixtures of ionic strength 0·20, the protein showed a single symmetrical peak in the electrophoresis apparatus at all *p*H values over the range *p*H 2–9. If the ionic strength was reduced to 0·02, there was partial resolution of two components over the range *p*H 3–5; but under more alkaline conditions no separation was observed at this ionic strength. At ionic strength 0·20 the value for the isoelectric point from the electrophoretic mobility measurements was 3·9, while that from membrane potential determinations was 4·0. On reducing the ionic strength to 0·02, there was a considerable change in the position of the isoelectric point; determinations in the dilute buffer gave 4·9 from electrophoresis measurements and 4·8 from membrane potentials.

The osmotic pressures of different fractions were determined for solutions buffered with sodium phosphate with a *p*H value of 7·4 and an ionic strength of 0·1. The initial solutions gave molecular weights of 60,000–65,000. However, when the initial solution was dialysed against buffer using a highly permeable collodion membrane, the non-diffusible fraction (which represented 60 per cent of the whole) gave a mean molecular weight of 84,000. This indicated that the primary extraction product was not homogeneous. Subsequent fractionation resulted in the separation of a major component (representing about 75 per cent of the protein) which showed the characteristic property of reversible heat precipitation, and a minor component which gave no precipitate at any temperature up to 100° when dissolved in buffer of low ionic strength. This latter component gave a mean molecular weight of 6,000 from osmotic pressure measurements.

In a number of experiments carried out with the ultracentrifuge by Dr. R. A. Kekwick, the primary extraction product and the protein derived from it by dialysis with a highly permeable membrane both gave a single peak at 270,000*g*, the rate of sedimentation being approximately the same in both cases. No indication of the presence of the minor component could be observed in the photographs.

The shape of curves obtained by titrating the protein in the presence of sodium chloride suggests a high content of α-carboxyl and α-amino groups not found in native elastin. This indicates that primary bonds have been broken during the hydrolytic treatment, and the evidence as a whole suggests that the mild hydrolysis has resulted in the fragmentation of the fibrous protein at certain reactive sites, thus liberating a large part of the material as molecules of rather uniform character. Full details of this work will be published elsewhere.

We wish to thank Dr. R. A. Kekwick for his part in examining the protein with the ultracentrifuge, and Mr. J. R. Bendall for a titration study. We have also particularly benefited from discussion with Dr. E. C. Bate-Smith.

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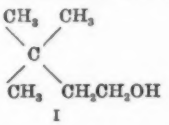
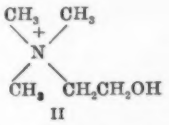
Pharmacological Activity of the Carbon Analogue of Acetylcholine

It has been shown by Adams and Whittaker[1-4] that both forms of mammalian cholinesterase hydrolyse aliphatic esters, those of 3 : 3-dimethylbutanol (I), the carbon analogue of choline (II), being particularly rapidly hydrolysed. Thus human[3] and horse[5] erythrocyte cholinesterase hydrolyse 3 : 3-dimethylbutyl acetate at 1·8 and 1·6 times the rate of acetyl-β-methylcholine respectively. It is therefore of interest to know something of the pharmacological properties of this compound.

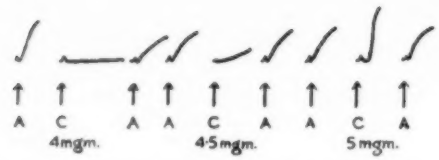


I



II

Two preparations have been used, namely, the isolated eserinized frog rectus abdominis muscle and the isolated guinea pig ileum. The carbon analogue of acetylcholine, in relatively high concentration, causes a contraction of the frog rectus (see p. 606), but its activity is only about 1/12,000 that of acetylcholine, that is, considerably less than that of choline, which was tested on the same preparation. In the guinea pig ileum, full contractions were never observed. Usually, sufficiently large doses



Frog rectus. After addition of drug, the muscle was allowed to contract for 90 sec. before being washed out with eserinized frog Ringer solution

A = 0·4 μgm. acetylcholine; *C* = 3 : 3-dimethylbutyl acetate

produced a small contraction the magnitude of which became constant with increasing doses at a few per cent of the total possible. It seems possible that 3 : 3-dimethylbutyl acetate has no effect on smooth muscle corresponding to that of acetylcholine or muscarine, and that these small partial contractions were due to stimulation of ganglion cells.

It is realized that the work described here is incomplete. The chief point that emerges is that the carbon analogue of acetylcholine has but little pharmacological action in spite of its fairly high rate of hydrolysis by cholinesterases. This illustrates once again the big differences of specificity which must exist between the active centres of the cholinesterases and the tissue receptors.

Since carrying out these experiments, we have been kindly informed by Prof. A. D. Welch, of the Western Reserve University, Cleveland, Ohio, of independent work on 3 : 3-dimethylbutyl acetate which was carried out in his department and which is in course of publication.

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Enzymic Scission of the Branch Links in Amylopectin

Amylosynthease, an enzyme discovered by Nishimura[1] in 1930, changes the red colour produced by iodine with cereal starches of the glutinous (waxy) variety into bluish-purple; it was therefore considered to be a starch-synthesizing enzyme. But having examined the mechanism of the action, we have reached the conclusion that this change in colour is not due to the synthesis of starch, but to the formation of amylose from amylopectin.

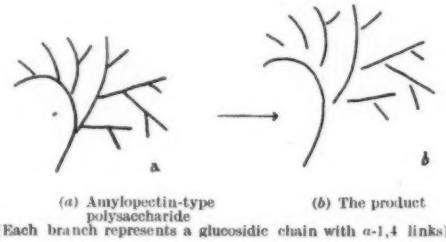
When a solution of glutinous-rice starch was acted upon by the enzyme from autolysed brewer's yeast at 20° C., and at *p*H 6·0–6·2, the iodine colour of the digest gradually turned to purple or bluish-purple, and a white precipitate appeared after several days. This precipitate is the modified polysaccharide produced by the enzyme. Its properties were compared with those of the glutinous-rice starch, as regards the molecular weight, the iodine colour, the conversion limit by β-amylase, etc.[2]. As shown in the accompanying table, the product had essentially a smaller

	Glutinous-rice starch	Product formed by the enzyme
Mean molecular weight determined by viscosity measurement	264,000	16,600
Mean molecular weight determined by osmotic pressure measurement	229,000	18,800–20,300
Iodine reaction	Red	Bluish-purple
Conversion limit by β-amylase	53 per cent	73 per cent
Retrograding tendency	negligible	very liable to retrograde
Precipitation by butanol	–	+

molecular size than the original substance, and showed very similar properties to those of amylose. The resemblance of the product to amylose was proved also by potentiometric titration with iodine[3]. An amylose-like substance was also obtained from glutinous-rice starch or potato amylopectin by the same method. While the enzymic production of amylopectin from amylose has been carried out by *Q*-enzyme, as shown by Peat *et al.*[4], its reverse process has never been observed with an enzyme system. It may thus be interesting that another enzyme is now found to perform the reverse process.

This enzyme action was not affected by the presence of inorganic phosphate. The enzyme could attack the limit dextrin produced by β-amylase, and allowed further degradation of this dextrin by β-amylase. It acted only on polysaccharides of ramifying structure (amylopectin-type) as the substrates, and it seemed to have no action on the amylose-type (non-ramifying) polysaccharides. Furthermore, no hydrolytic action was observed on a sample of bacterial dextran[5] produced by *Leuconostoc mesenteroides*, a strain of which was kindly supplied by Dr. E. J. Hehre.

In order to account for the formation of amylose-type substance, several possible processes were considered. But the hypothesis was finally adopted that the enzyme attacks the points of branching in the glucosidic chains (α-1,6 linkages), and produces amylose-like substances. This mode of action is illustrated schematically in the figure.



(*a*) Amylopectin-type polysaccharide (*b*) The product
(Each branch represents a glucosidic chain with α-1,4 links)

All the experimental evidence can be reasonably explained by this scheme. It is, of course, not impossible that the process is the real reverse reaction of *Q*-enzyme; however, no evidence has been found in support of this possibility.

In conclusion, this enzyme may be considered as an amylase of a particular type, having the power of hydrolysing amylopectin-type polysaccharides at the points of branching of glucosidic chains. We propose to give this enzyme the name '*iso*amylase' instead of the old, misleading name, 'amylosynthease'.

Note added on March 5. Hobson, Whelan and Peat[6] have isolated the 'debranching' enzyme (*R*-enzyme) in broad bean and potato, and reported on its action. From their account, the action of

R-enzyme is exactly the same as that of the *iso*amylase described by us, and their interpretation of its action coincides with ours.

The existence of amylosynthease (*iso*amylase) in potato was mentioned in 1932 by Minagawa[7]. Since then, the distribution of the enzyme has been extended to many plants other than yeast and potato[8]. There seems to us to be no doubt that the *R*-enzyme of Hobson, Whelan and Peat is *iso*amylase itself, and we are pleased to find that they gave the same interpretation to the action of *R*-enzyme as we did to that of *iso*amylase.

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Estimation of Protein Hydration by Dielectric Measurements at Microwave Frequencies

DIELECTRIC measurements of protein solutions[1] show relaxation of the protein molecule at frequencies of the order of 10^6 cycles/sec., the dielectric constant falling to a constant value (ε_s) in the region 10^7–10^9 cycles/sec. Oncley[2] suggested that measurement of ε_s might be used for estimating protein hydration.

It is now possible to make accurate measurements in the microwave region (wave-lengths 10–1 cm.), and results for ionic solutions[3] are in agreement with expected values for the hydration of ions. Moreover, since the water molecules show a relaxation in this range, it is possible to draw some conclusions about the state of the water around the ions. It is likely that measurements of protein solutions in the microwave region will give estimates of hydration, and that measurements of solutions of smaller molecules with similar polar groups will give some information about the water structure around the protein.

Albumin concentration	$\lambda = 1{\cdot}264$		$\lambda = 3{\cdot}175$		$\lambda = 9{\cdot}22$		λ_s	ε_s
	ε'	ε''	ε'	ε''	ε'	ε''		
0·0% (water)	34·7	35·5	63·3	28·8	76·5	11·9	1·57	78·3
3·1%	32·9	34·0	60·3	27·5	74·0	12·1	1·57	74·8
6·15%	31·2	31·9	57·2	26·4	70·6	11·8	1·58	71·5
9·2%	29·8	30·1	54·2	25·2	66·0	11·6	1·59	67·8

The results shown in the accompanying table have been obtained for bovine serum albumin at 25·0° C. Small conductivity corrections have been made (see ref. 3).

The measurements at 9·22 cm. were made by the method of C. H. Collie *et al.*[4] with improved water cell and screening, the measurements at 3·17 and 1·26 cm. by a balance method to be described elsewhere[5]. The estimated accuracy in ε' and ε'' is ± 1 per cent.

The protein solutions were prepared by dissolving Armour bovine plasma albumin fraction V in distilled water, the protein content being determined by the micro-Kjeldahl method (conversion factor 6·25) at the Courtauld Institute of Biochemistry. The *p*H was 7·0–7·3.

The measured values of ε' and ε'' satisfy Debye equations with relaxation times equal to that of water at 25·0° C., and with values of ε_s given above. A few measurements with a 10 per cent solution at other temperatures show the same decrement in ε_s, and the same relaxation times as water at these temperatures.

If we suppose that w gm. of water is associated with 1 gm. of protein in such a way that it no longer contributes to ε_s, then, to a first approximation:

$$\varepsilon_s = \varepsilon_{\text{water}} - \delta.c$$

$$\frac{\delta}{\beta} = \frac{(\varepsilon_{\text{water}} - \varepsilon_{\infty\text{protein}})\ v + (\varepsilon_{\text{water}} - \varepsilon_{\infty\text{water}})w}{100},$$

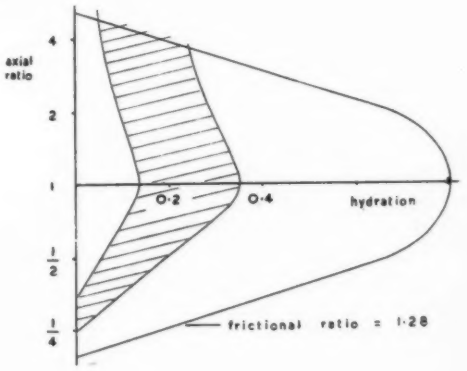
where c is protein concentration in gm./100 c.c. of solution, v is partial specific volume of protein (0·74 for serum albumin), $\varepsilon_{\infty\text{protein}}$ is high-frequency dielectric constant of protein (= 2), and $\varepsilon_{\infty\text{water}}$ is high-frequency dielectric constant of water[4] (= 5·5).

It can be shown theoretically that $\beta = 3/2$ for a random distribution of spheres of low dielectric constant in a medium of high dielectric constant[5], and the variation of β with axial ratio can be calculated for a random distribution of spheroids[7].

The experimental results ($\delta = 1{\cdot}1$) combined with a frictional ratio 1·28 [6] suggest an elongated rather than a flattened molecule, with hydration 0·15 ± 0·1 gm. water/gm. protein. Similar measurements give a hydration value very close to this for methæmoglobin.

It is to be expected that these values will be rather lower than those estimated by other methods[6,9] if most of the bound water molecules are not in the interior of the molecule, but are bound by hydrogen bonds to charged groups in the protein surface. In this case the 'bound' water will still make some contribution to ε_s.

Making an allowance for this contribution, the uncertainty of our estimate for serum albumin is shown by the shaded area in the accompanying figure.



It should be noted that these conclusions depend very critically on the validity, in the present case, of the dielectric theory to which reference is given above.

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Oxidation of Anthoxanthins by Tea-Oxidase

Paper chromatography has revealed the presence in tea-leaf of a large number of substances giving a yellow colour on the chromatogram on exposure to ammonia vapour. These are regarded as anthoxanthins, and two of them have been identified as rutin and quercitrin[1]. Chromatograms of fermented tea show the same pattern of anthoxanthin spots, which suggests that these substances are not oxidized enzymically by the tea-oxidase, although some of them presumably contain catechol or pyrogallol groupings in their molecules.

In order to confirm this point, a manometric study has been made of the oxidation of anthoxanthins containing such groupings. Substrates chosen include quercetin, myricetin, quercitrin, myricitrin, rutin and butin. The enzyme preparation was acetone-dried tea-leaf washed free from amino-acids and polyphenols as described by Roberts and Wood[2].

Table 1 gives typical uptakes for the oxidation of these substrates in the presence of 40 mgm. enzyme at *p*H 5·6 and 32° C. Figures for *dl*-catechin are also tabulated for comparison.

Table 1. Comparative Rates of Oxidation of Substrates

Substrate	Oxygen uptake (μl.)						
	10	30	60	120	180	240	300 min.
Quercetin (5 mgm.)	—	—	—	12			
Myricetin (10 mgm.)	45	128	228	356	443	496	544
Quercitrin (5 mgm.)				nil			
Myricitrin (5 mgm.)	—	—	—	3			
Rutin (5 mgm.)	—	—	—	4			
Butin (8·1 mgm.)	38	95	160	246	310	352	384
dl-Catechin (8·7 mgm.)	100	230	272	287	294	296	302

Quercetin, its glycosides, and myricitrin are not appreciably oxidized. (The slight oxidation of rutin previously observed by Roberts and Wood[2] is not confirmed.) Myricetin is oxidized at nearly half the rate at which an equimolecular quantity of *dl*-catechin is oxidized, and the initial rate for an equimolecular quantity of butin is not much less than the rate with myricetin.

In conformity with previous findings on the enzymic oxidation of substrates containing a free pyrogallol group, myricetin yields carbon dioxide on oxidation ($R.Q.$ = 0·46) and oxidation proceeds well beyond the *o*-quinone stage. Butin yields negligible amounts of carbon dioxide on oxidation but gives an uptake considerably in excess of that required for one atom of oxygen per molecule.

Quercetin and its glycosides are not oxidized by systems consisting of *dl*-catechin and tea-oxidase, but myricitrin, although not oxidized directly by the enzyme, is oxidized when *dl*-catechin is also present, as shown in Table 2.

Table 2. Oxidation of Myricitrin by Tea-Oxidase + *dl*-Catechin

Substrate	Oxygen (μl.)	CO_2 (μl.)
dl-Catechin (10 mgm)	360	nil
,, + myricitrin (5 mgm.)	566	104

Uptakes quoted are those determined after 150 min., and do not include oxygen consumptions in the 10 min. of equilibration.

Appreciable amounts of carbon dioxide are produced when myricitrin is oxidized by the *o*-quinone of *dl*-catechin.

Although myricetin and butin are oxidized less rapidly than *dl*-catechin, addition of these substances does not significantly depress the rate of enzymic oxidation of *dl*-catechin. Table 3 illustrates the absence of mixed-substrate effect with *dl*-catechin and butin. The effect with myricetin is similar. The carbon dioxide output from myricetin is considerably increased in the presence of *dl*-catechin, indicating further oxidation of the pyrogallol group by the *o*-quinone of *dl*-catechin.

Table 3. Mixed Substrate Effect with *dl*-Catechin and Butin

Substrate	Oxygen (μl.)					
	15	30	60	120	180	240 min.
dl-Catechin (10 mgm.)	78	148	261	367	406	422
,, + butin (5 mgm.)	77	147	259	382	448	490

The absence of a mixed-substrate effect is believed to indicate that oxidation of the two substrates takes place successively and that in the initial stages only the more rapidly oxidized substrate (*dl*-catechin) is oxidized (cf. Roberts and Wood[2]).

These results confirm earlier findings[2] that pyrogallol derivatives are oxidized more rapidly by the tea-oxidase than catechol derivatives. Comparing quercetin with butin, it appears that flavonols are less readily oxidized than flavanones and that catechins are oxidized more readily than either. The carbon skeleton in the oxygen ring, therefore, appears to have a considerable effect on the ease of oxidation of the catechol side-group. Glycosidation appears to result in a more or less complete inhibition of oxidation.

Results to be presented later indicate that the anthoxanthins present in tea are all glycosides, so that the foregoing results are in accordance with the conclusion, previously drawn, that anthoxanthins in the tea-leaf are not oxidized during fermentation.

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Efficiency of Food Utilization for Milk Production

THE concept of efficiency of output may be real but may vary according to preference for an economic, or a physiological, or other form of definition. In any event, the exigencies of the present agricultural situation focus attention more sharply on the problem of how the most efficient response of the productive unit to husbandry may be secured, whether the unit be plant or animal, an individual, a group, or a population. For animals, a food input–realizable product output relationship, however it may be expressed, would appear to provide a reasonable basis for assessing efficiency. Leitch and Godden[1] reviewed work on these lines and suggested measures of comparing efficiencies of the different species and kinds of farm livestock. Comprehensive reference to work on this subject is not intended in this communication, the purpose of which is to indicate only a possible method of overcoming some of the practical problems in applying this concept.

For the milch cow—nowadays a particularly appropriate animal for examination in this light—American workers have made many estimates on an energy basis, in terms of total digestible nutrients consumed and quantity of milk produced, the latter being expressed as 4 per cent or Fat Corrected Milk. Recently, Mitchell[2] has discussed the similar concept applied to quantity of butter fat produced by cows in New Zealand. So far as Great Britain is concerned, attention to the problem has been meagre, although the need for it has often been stressed by practical farmers, notably, for example, by E. R. Cochrane[3], who strongly advocated the adoption, on the Scandinavian models, of food-recording schemes to relate to milk-production records. Edwards[4] used the American method in studying efficiency of output in a limited sample of cows, over a short period, and under special conditions obtaining at the Dairy Show. Halnan[5] estimated the protein conversion efficiency of dairy cows (and of other animals) in terms of the digestible protein in their feeding-stuffs and the edible protein in the products.

Wright and Fowler[6], applying Leitch and Godden's principles, proposed a measure whereby requirements of farm production of feeding-stuffs could be estimated in relation to targets of farm milk production, it being reckoned that each gallon of milk yielded needed 2 lb. of protein equivalent available for the herd, including young and dry stock as well as cows in milk. This provided a fairly direct and widely applicable alternative to other methods, for example, of calculating requirements on the basis of average rations for maintenance and for production, with, in some instances, the numbers of stock of various ages, etc., converted to some system of 'stock units'. The rations in such cases in British conditions have been almost invariably those suggested by Woodman[7], which form the basis for most of the 'rationing' systems that may be used in practice as guides to the varying requirements of cattle of different breeds, weights and levels of production.

Food recording is carried out by very few farmers; it will probably be a very long time before it is adopted as widely as milk recording and butter-fat testing, if it ever will be. 'Rationing', though probably expanding in use in some form or another, cannot be precisely applied to the individual animal, between animals, or between herds.

Yet the need for some, even rough, measure of the efficiency of food utilization by the animals in the herd remains, especially if it is desired to have an indication of comparative efficiencies. Such a need has been emphasized in connexion with a series of studies on milk-production levels and husbandry systems, which is being carried out in this Department.

Milk records alone give some comparison, in terms of X lb. milk, with y per cent fat, in Z days, between cows or between lactations of the same cow; various correction factors, for age, dry period, service period, frequency of milking, and so on, may be applied to convert lactation yields to a 'standard' basis, which may well give no advantage over the raw figures for many practical purposes. At best, these records give only a limited view of differences in efficiency, especially if they are to be used in herd averages, to reveal herd differences. Several methods of incorporating milk-production figures with other cow and herd data have been tried in order to estimate efficiency; one index has been found with the merit of easy calculation, which can be widely used, provided that proper precautions and reservations are made in its application. It has the admitted weakness of accepting Woodman's normal maintenance and production requirements as reasonably applicable in circumstances which vary widely; but for our purposes, and possibly many others, it serves to detect different orders of efficiency of food utilization, using protein as the important factor.

Apart from the usual assumptions in using protein requirements for production and for maintenance, it is also assumed that any allowance made in 'steaming up' a cow will be cancelled out by any withheld while she is being dried off at the end of lactation, and that it is logical to charge a cow with maintenance while she is dry as well as while she is in milk. Thus the index is the ratio, expressed as a percentage, of the total amount of digestible protein used for milk production in a lactation to the protein so used *plus* that used for maintenance during the time of that lactation and the associated dry period. Maintenance from calving to subsequent calving can be taken if necessary, or a broader approximation, applicable with additional reservations, can be derived from 'official' lactation records, using a 305-day lactation yield and a 365-day maintenance period. Weight and breed of animal, yield and butter-fat content of the milk are allowed for as in the standard tables of protein requirements; if actual live-weights are known, as in some of our material, these can be used to reduce part of one of the general assumptions. Efficiencies (E) at different live-weights (with m protein requirement per day) and levels of production in gallons (G) of milk, at butter-fat contents needing p protein per gallon, during maintenance periods of D days, can thus be compared:

$$\frac{E_1}{E_2} = \frac{G_1p_1(G_2p_2 + D_2m_2)}{G_2p_2(G_1p_1 + D_1m_1)}.$$

A full account of the estimates so far derived for a wide range of animals and herds, and of their interpretations, is being prepared for publication elsewhere by Y. M. Tolba, who with A. Osborne has carried out the major part of the computations. For the present, an idea of the order of indexes of overall food utilization efficiency can be indicated by the following. An 'average' Friesian or Shorthorn cow of 11 cwt. live-weight with milk of 3·5–3·8 per cent

butter-fat content, in a 365-day period would show 50 per cent efficiency when producing a 456-gallon yield, 70 per cent at 1,066 gallons, 80 per cent at 1,827 gallons, etc.; a smaller cow of 7 cwt. live-weight, giving milk with 5·1 per cent fat, for example, a Jersey, would attain the same values at yields of 219, 511 and 876 gallons respectively.

An increase in calving interval, or a lengthened dry period, extending the maintenance period to 465 as against 365 days in the case of an 11-cwt. cow producing 800 gallons of milk of 3·5 per cent fat in a lactation would reduce her index, approximately, from 63·7 to 57·9 per cent, or equivalent only to about a 600-gallon cow on a yearly maintenance basis. Extended dry periods of this order are perhaps no less common than 200-gallon differences between cows and lactations; they represent serious wastage in the industry in loss of potential milk production and in unprofitable food consumption.

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Grazing Behaviour of Dairy Cattle in the Tropics

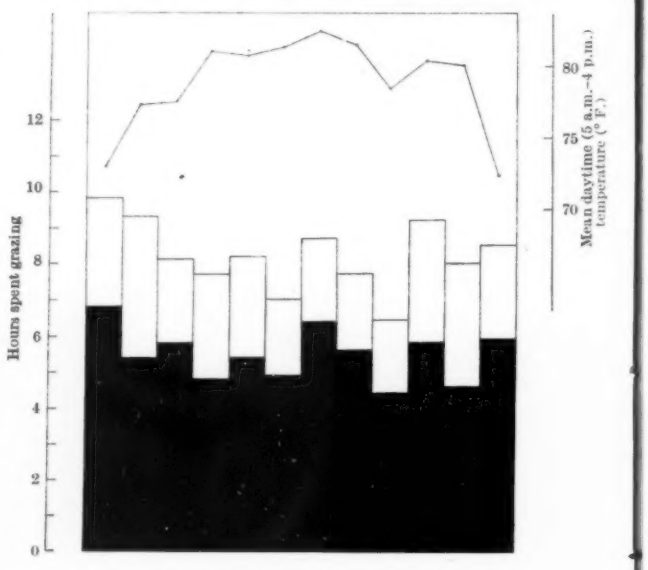
Comprehensive studies have been made of the grazing behaviour of cattle in countries with a temperate climate, and the literature on the subject has been ably summarized by Johnstone-Wallace and Kennedy[1], Tribe[2], and Worden[3]. There are, however, no references in the literature to similar studies in the tropics; and information available on the behaviour of cattle in a hot climate, recently reviewed by Findlay[4], has been derived from daytime observations or the very short-term investigation of Seath and Miller[5], who studied the grazing behaviour of six dairy cows for five consecutive twenty-four hour periods.

At this station we have completed what is, so far as we know, the first comprehensive investigation into the behaviour of dairy cows in the tropics. Six grade Friesian cows with approximately the same productivity were selected from the station herd. They were managed in the same way as, and run with, the remainder of the dairy herd. Each cow was observed for a twenty-four hour period, at approximately monthly intervals, for the twelve months beginning August 1949 and ending July 1950. The observers sat in a small portable shelter which was shifted as the animal moved, and they noted the behaviour of the cow over five-minute periods for twenty-four hours.

The cows were shown to graze according to a pattern that did not vary widely from cow to cow or from month to month. As soon as afternoon milking was ended, that is, at 3.30–4.30 p.m., the cows would graze continuously for three to four hours, rest for one to two hours, and after micturating and/or defæcating, start grazing again. This alternation of grazing and resting would continue throughout the night; but towards morning the grazing periods grew shorter and the resting periods longer, until at approximately 3 a.m. the cows stopped grazing and rested until the morning milking at 5 a.m. When morning milking was finished, the cows would start grazing immediately and graze intermittently until approximately 1 p.m., when grazing usually ceased except for very short periods. The pattern of resting altered as from night to day. At night the cows spent 19 per cent of their lying-down period in the shade, whereas during the day 66 per cent of this period was so spent.

The accompanying histogram shows the total grazing time and the day and night grazing time month by month. It will be noted that the cows grazed mainly at night (67 per cent of the total grazing time), that the total grazing time tended to fall during the hot months, and that this fall was mainly due to a slight diminution in the length of daytime grazing.

We conclude from these observations that the grazing behaviour of European-type cattle is radically different in the tropics from that in the temperate zone. Consequently, there is a danger that techniques of management originating in the temperate zone will give poor results if applied in the tropics. New techniques of management based on behaviour observations must be introduced for European-type cattle in the tropics. It seems from our observations that dairy cattle should be placed in the best pasture at night and early in the morning, and that they require shady paddocks for daytime grazing.



Total and day and night grazing times of a Friesian herd in Fiji during August 1949–July 1950. ■, night grazing; □, day grazing

We are indebted to the Director of Agriculture, Fiji, for providing facilities for this study and for permission to publish this work, of which a more detailed report will appear elsewhere.

W. J. A. Payne
W. I. Laing
E. N. Raivoka

Department of Agriculture,
Sigatoka, Fiji. Nov. 24.

[1] Johnstone-Wallace, D. B., and Kennedy, K., *J. Agric. Sci.*, **34**, 190 (1944).
[2] Tribe, D. E., *Emp. J. Exp. Agric.*, **17**, 105 (1949).
[3] Worden, A. N., *New Biol.*, **7**, 9 (1949).
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Mutations appearing in *Fusarium cæruleum* Cultures treated with Tetrachlornitrobenzene

Fusarium cæruleum (Lib.) Sacc., unlike many other Fusaria, is comparatively stable under normal conditions, and mutations in culture are uncommon. During an investigation of the effect of tetrachlornitrobenzene on the growth-rate of the fungus in culture, however, a number of mutant forms made their appearance. Cultures on potato dextrose agar were exposed continuously to tetrachlornitrobenzene vapour by depositing 0·01 gm. of the pure chemical on the inside of the Petri dish lids. In a typical experiment, thirteen plates were each seeded with a single spore; twenty-eight mutant sectors (at least one in each plate) developed in ten treated plates, while none was found in three untreated control plates.

Certain of the mutant sectors were characterized by a growth-rate faster than that of the normal strain from which they originated. Subcultures were taken from these and compared with subcultures of the normal strain, in the absence of tetrachlornitrobenzene. Under these conditions, the mutants were found to be very similar in growth-rate, general appearance and spore measurement to the normal strains, and fell within the range of variability found in isolates from natural sources. Laboratory pathogenicity tests, moreover, did not show any difference in virulence between these mutants and the normal strains.

Further studies on the growth-rate of the mutant and normal strains confirmed that, in the presence of tetrachlornitrobenzene, the growth-rate of the former was markedly greater than that of the latter. From this it was concluded that the new strains were in the nature of physiological mutants, distinguished by their ability to resist the fungistatic action of the vapour. This resistance to the effects of tetrachlornitrobenzene was unaltered after passage of the fungus through potato tubers (see table).

As these new strains arose in single-spore cultures, it would appear likely that they are true mutations and not merely more resistant individuals which were undetected until subjected to treatment with tetrachlornitrobenzene. Although the *Fusarium* macrospore is multinucleate, heterokaryosis is improbable as, at least in some Fusaria, it has been shown[1] that these nuclei arise from a single parent nucleus. A number of chemicals are known to induce mutation in fungi, but the possibility must always be considered that an apparently homogeneous colony does, in fact, contain mutant loci which are unable to develop until the dominance of the 'normal' strain is restricted by the action of the chemical in question.

Average Increase in Colony-Diameter per Day in cm. (at Room Temperature) for a Normal and Mutant Strain of *F. cæruleum*

Strain		In absence of tetrachlornitrobenzene	In presence of tetrachlornitrobenzene
Normal	*a*	0·68	0·31
	b	0·66	0·28
Mutant	*a*	0·67	0·54
	b	0·66	0·50

a, Original isolate; *b*, after passage through potato tubers.

Tetrachlornitrobenzene is the active principle of a dressing used for preventing potato dry rot and is normally applied to newly dug potatoes before storage. The extent to which mutants of *F. cæruleum* appear in soil adherent to the tubers after this treatment has not yet been investigated, but it seems possible that strains resistant to tetrachlornitrobenzene may arise and be distributed afterwards among the soil population. The mode of action of tetrachlornitrobenzene in controlling dry rot is obscure, as *in vitro* the chemical restricts the growth of the fungus but by no means prevents it; when the chemical is removed, the fungus resumes its normal growth-rate. It cannot be assumed that mutants which are able to grow faster in the presence of tetrachlornitrobenzene would necessarily cause more dry rot in potatoes treated with tetrachlornitrobenzene than the normal strains.

R. K. McKee

Agricultural Research Council
Potato Storage Investigation,
c/o University of Nottingham
School of Agriculture,
Sutton Bonington,
Loughborough, Leics.
Nov. 27.

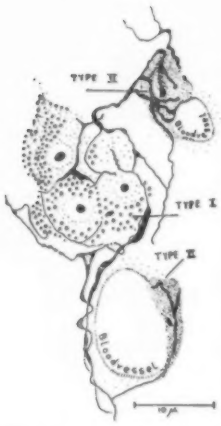
[1] Dickinson, S., Minn. Agric. Exp. Sta. Tech. Bull., 88 (1932).

Histology of the Carotid Body

De Castro's histological[1] and Heyman's physiological[2] investigations on the carotid body have provided new and important evidence of a peripheral control of respiration and circulation. Histologically, much work has been done to elucidate the mode of nervous innervation of the chemo-receptive tissue in the carotid body; but little is known of the underlying mechanism by which chemical changes in the blood give rise to afferent impulses in the sinus nerve, for example, whether the receptors concerned are specialized in relation to the nature and concentration of particular stimuli. Anderson and Zotterman[3] were able to demonstrate that specialized receptors for 'water taste' as distinct from acid receptors exist in the frog's tongue. Von Euler, Liljestrand and Zotterman[4] obtained results "which strongly suggest identical receptors" for anoxic and hypercapnic stimulation. Winder[5] leaves open the question of separate receptor sets for oxygen and carbon-dioxide stimulation.

The issue of possible receptor specialization has been examined histologically. A number of workers have reported differing types of receptor cells in the carotid body of several species[6–11]. Few observations are, however, available concerning the distribution or morphological relationships of such cells.

Carotid bodies were taken from the cat under ether. The bifurcation of the common carotid was removed within thirty to sixty seconds of death and at once fixed. Paraffin sections[6] were treated according to Holmes's silver technique[12]. The greater part of the



carotid body was found to consist of a typical rounded glomus cell (type I), staining blue-grey, with a very granular cytoplasm. In addition, cells are present staining pinkish-red (type II), without cytoplasmic granulations, of irregular shape, lacking the compact rounded form of type I. They are characteristically interposed between the sinusoidal blood spaces and groups of type I cells, or are found closely applied to the latter. They usually occur singly, less commonly in small groups. The rich nervous plexus which supplies glomus cells of type I also innervates type II. In any section, several fine fibres are usually seen to pass from the one to the other (see diagram).

These findings appear consistent with the existence in the cat's carotid body of two separate sets of receptors, using the same afferent pathway; alternatively, the two types of cells present may be functionally dependent on one another.

These findings will be reported in detail in due course.

L. L. de Kock

Natural History Department,
Marischal College,
Aberdeen. Dec. 4.

[1] de Castro, F., *Z. Anat. Entw.*, **89**, 250 (1929).
[2] Heymans, C., Bouchaert, J. J., and Dautreband, L., *Arch. int. Pharmacodyn.*, **39**, 400 (1930).
[3] Anderson, B., and Zotterman, Y., *Acta Phys. Scand.*, **20**, 95 (1950).
[4] von Euler, U. S., Liljestrand, G., and Zotterman, Y., *Scand. Arch. Phys.*, **83**, 132 (1939).
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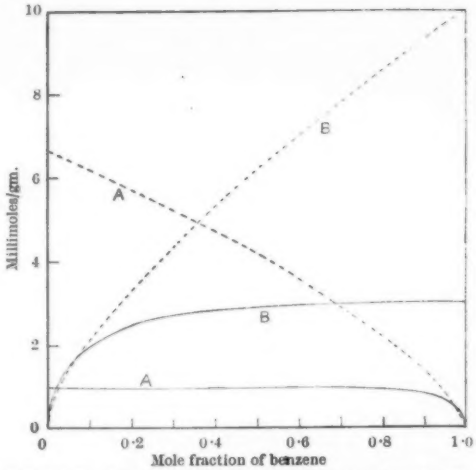
[12] Holmes, W., "Microt. Vademecum", 537 (11th Edit., 1950).

Adsorption from Binary Mixtures of Non-electrolytes

It was suggested many years ago[1] that both components of a binary liquid mixture of non-electrolytes are adsorbed by solids such as charcoal and silica gel, though, with notable exceptions[2-4], this concept has not always been considered in recent work. What has usually been called the 'adsorption isotherm' is thus the resultant of the addition of two individual isotherms, which cannot be determined directly. Bartell and Sloan[3] have investigated the possibility (originally suggested by Ostwald and de Izaguirre[2]) that the individual isotherms follow Freundlich equations. By a process of successive approximations they obtained the constants for two such equations, and showed that the 'composite' equation thus derivable for the conventional adsorption isotherm gave a close fit with the experimental curves for a number of systems, including benzene – ethyl alcohol – charcoal.

In the study of adsorption from the gaseous state, the Freundlich equation has been superseded by the



'Individual' absorption isotherms plotted according to the Langmuir equation (full line) and the Freundlich equation (dotted line): (*A*) ethyl alcohol; (*B*) benzene

Langmuir equation. We have now found that a similar process of successive approximations gives a pair of Langmuir equations from which a composite equation can also be derived. The conventional adsorption isotherm has been obtained for the system benzene – ethyl alcohol with a sample of steam-activated nutshell charcoal. It can be represented equally well by the two composite equations:

$$\frac{H.\Delta N}{m} = 10{\cdot}0\,N^{0{\cdot}68}(1-N) - 6{\cdot}65\,(1-N)^{0{\cdot}68}N$$

(Freundlich type)

$$\frac{H.\Delta N}{m} = \frac{50{\cdot}0N\,(1-N)}{1+15{\cdot}6\,N} - \frac{50{\cdot}0\,(1-N)N}{1+50{\cdot}0\,(1-N)}$$

(Langmuir type)

where N is the mole fraction of benzene at equilibrium, H is total number of moles of solution added to m gm. of charcoal. From the accompanying graph, however, it is seen that the two treatments give widely divergent results for the individual isotherms. Those from the Freundlich equations are of similar form to those which can be plotted from the results of Bartell and Sloan. The Freundlich equations for both sets of data, however, give maximum values for the amounts of benzene held by the charcoals, which seem very high unless multilayer adsorption is postulated.

This disagreement suggests that at least one of the treatments is invalid, and it seems likely, on theoretical grounds, that the mathematical forms of both equations render them inapplicable to liquid-phase results.

We hope to publish further details of this investigation elsewhere, together with a method for obtaining more satisfactory isotherms for the adsorption of the individual components in such systems.

J. J. Kipling
D. A. Tester

University College,
Hull.
Nov. 20.

[1] Williams, *Medd. K. Vetenskapsakad. Nobelinst.*, **2**, No. 27 (1913).
[2] Ostwald and de Izaguirre, *Kolloidzschr.*, **30**, 279 (1922).
[3] Bartell and Sloan, *J. Amer. Chem. Soc.*, **51**, 1643 (1929).
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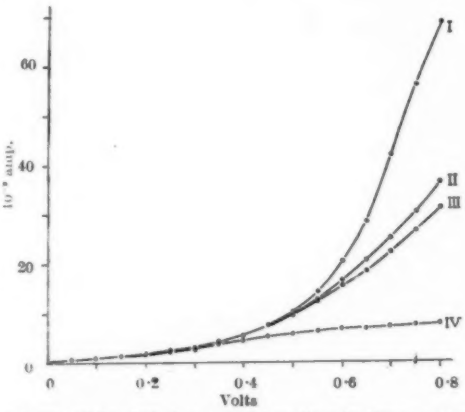
Structure of the Electrocapillary Double Layer and the Overvoltage of Electrolytic Reactions

It is generally accepted[1,2] that the electrolytic double layer plays an important part in the establishment of potential barriers at electrode surfaces. It is difficult, however, to prove this phenomenon experimentally. It is true that, in order to modify the electrocapillary potential, the composition of the solution has to be changed; but this, in turn, throws doubt upon the interpretation of the results[3].

It is known that the double layer is composed of a rigid part, bound to the electrode by relatively strong adsorption forces, and of a diffuse part, linked to the first by electrostatic forces. The thickness of this diffuse part is approximately proportional to the inverse square root of the ion concentration[4].

In extremely dilute solutions it is possible to obtain sufficiently extended diffuse layers, so that a laminar movement may destroy their orderly structure. By reducing the electrostatic compensation, such a movement would provoke an increase of the potential of the adsorbed layer and, consequently, a rise of the overpotential if the adsorbed layer constitutes a potential barrier.

In order to carry out electrolysis in a medium of very low concentration, we used as a reactant oxygen dissolved in water of 10^{-7} mhos conductivity. A platinum wire of 0·2 mm. diameter, which did not protrude over the surface of the glass, constituted a rotating electrode[5]. The anode was a cylindrical surface surrounding the rotating electrode; its area was 12 cm.^{2}. We may hence consider the anode as unpolarizable with respect to the cathode. In these circumstances, it is observed that, at a given potential, the reduction current of the oxygen is much decreased when the electrode is moving. This effect is only perceptible at low speeds of rotation. At higher speeds the motion reduces the thickness of the 'diffusion layer', thus again increasing the current. The addition of a small quantity of electrolyte suppresses the phenomenon: at concentrations of potassium chloride greater than 2×10^{-4} *M* the effect ceases to be apparent.



Influence of the electrode movement on the reduction current of oxygen.

Curve I, electrode stationary; curve II, electrode making one revolution in 4 sec.; curve III, electrode making one revolution per sec.; curve IV, residual current in the absence of oxygen; this current is not influenced by the motion of the electrode

The accompanying graph shows the curves representing the current intensity as a function of the applied potential for different speeds of rotation. The measurements are perfectly reproducible, and we have checked that without polarization the motion of the electrode does not produce any measurable current, even at high speeds of rotation.

J. van Cakenberghe

Laboratoire de l'Association pour
les Études Texturales,
4 rue Montoyer,
Brussels.
Nov. 28.

[1] Kimball, G. E., Glasstone, S., and Glassner, A., *J. Chem. Phys.*, **3**, 91 (1941).
[2] Frumkin, A., *Z. phys. Chem.*, A, **164**, 121 (1933).
[3] de Bethune, A. J., *J. Amer. Chem. Soc.*, **71**, 1556 (1949).
[4] Verwey, E. J. W., and Overbeek, J. Th. G., "Theory of the Stability of Lyophobic Colloids", 29 (Amsterdam, 1948).
[5] Kolthoff, I. M., and Lingane, J. J., "Polarography", 440 (New York, 1946).

In the course of experiments on overpotential at low current densities, during the past four years, we have frequently observed that stirring the solution affects the overpotential. Although our work is far from complete, we now have considerable evidence that, if very great precautions are taken to exclude oxygen and also any products of electrolysis arising from the anode, stirring has little or no effect on the potential of a cathode of a noble metal. For example, some time ago, using cells in which a smooth tungsten or platinum anode was separated from a gold cathode only by a sintered glass plug, stirring caused a considerable lowering of overpotential at the cathode, with polarizing currents less than about ten microamperes per sq. cm. In later work, using very great care over purity of materials and cleanliness of apparatus, and an anode of platinized platinum which could be in the same solution as the cathode, stirring did not affect the potential of cathodes of platinum or gold appreciably. The platinized anode, in the atmosphere of hydrogen, also carefully purified, reduces completely any oxygen produced at the anode, provided that the current is less than about 160 μamp./cm.^{2}; this is confirmed by its potential remaining steady at the reversible hydrogen value. With these conditions, stirring had no effect on cathodic potential between 0·05 μamp./cm.^{2} and 100 μamp./cm.^{2}.

The potential of copper cathodes, in 0·1 *N* hydrochloric acid, was considerably decreased by stirring, up to 10 μamp./cm.^{2}; at higher currents, stirring had little effect. There was evidence that the copper electrodes had dissolved to a slight extent; we think that stirring assisted diffusion of the previously dissolved copper ions to the cathode, thus increasing the concentration of cations and making it easier for current to pass. At the higher current densities, either the copper ions have been cleared prior to stirring, or the rate of transport of cations under the potential gradient alone is so great that stirring makes little difference.

We think that the changes in the potential for a given current in the presence of oxygen, described by van Cakenberghe, may be due to changes in the concentration of oxygen, or possibly minute traces of surface-active impurities, very near the electrode, where oxygen probably reacts with hydrogen atoms adsorbed on the electrode surface. There seems no

convincing evidence that this amount of stirring appreciably alters the distribution of ions in the double layer.

N. K. Adam
E. W. Balson
F. D. Hills

University College,
Southampton.
Dec. 13.

Artificial Stimulation of Rain at Kongwa

The Overseas Food Corporation, in collaboration with the East African Meteorological Department, is conducting a series of experiments at Kongwa, Tanganyika, on the artificial stimulation of rainfall. The experiments will continue until the end of the rainy season in April this year. These experiments are based upon the well-known principle that silver iodide particles may, under certain conditions, act as sublimation nuclei in supercooled clouds, and the Kongwa experiments involve the production of silver iodide particles in two ways.

In the first method, charcoal impregnated by immersion in an acetone solution of silver iodide is burned in a number of ground generators spaced in a line to the windward of the Overseas Food Corporation area of cultivation. This method has already been used in experiments in the United States and it is unnecessary to describe it further[1].

The second method is believed to be a new development. The silver iodide particles are produced by the explosion of small charges of gunpowder which have been impregnated with silver iodide in a similar manner. Each charge normally consists of 15 gm. of gunpowder. These charges are carried into suitable clouds by hydrogen-filled balloons, the explosion being effected by a time-fuse which is set to explode at approximately the freezing-level of 15,000 ft. This is achieved by filling the balloons to give a rate of ascent of approximately 500 ft. per min. and adjusting the length of time-fuse accordingly. The particles are thus released at about the freezing-level in clouds which are assessed as extending further vertically at least to a height at which a temperature of − 5° C. may be expected, this being the lowest temperature at which silver iodide particles can be effective. The further upward movement of the particles to such a height is effected by the natural vertical currents in the cloud. The 'aiming' of the 'balloon-bombs' is assisted by measurements of upper winds by the normal pilot balloon theodolite method.

It is believed that this second method is likely to be much more effective than the method involving ground generators, for several reasons. (*a*) There can be selective seeding of the clouds, and only those which seem to extend to the necessary heights are experimented upon. (*b*) The particles are released at a level very near the level at which they become effective. In the ground-generator method, natural vertical currents in the atmosphere have to be relied upon to convey the particles from ground-level up to the levels at which they become effective. (*c*) The method of production of silver iodide particles by explosion is likely to be much more effective than that of ground generators. The production of the particles requires the vaporization of the silver iodide by a high temperature followed by rapid cooling. The gunpowder charge is held in small thin metal cylindrical containers and a very high temperature is reached during explosion. The temperature of the environment being about 0° C. produces a rapid cooling effect.

An acetone solution of silver iodide prepared in the manner described by Vonnegut[2] is used for impregnating the charcoal. A 2 per cent solution has been used giving a 1 per cent by weight impregnation of charcoal. Experiments using other concentrations of charcoal will probably be conducted later. For impregnating the gunpowder a solution of much higher concentration is used. The solution in this case is prepared by dissolving 15 gm. of potassium iodide and 50 gm. of silver iodide in 200 gm. of acetone. The solution is found to result in an impregnation of 1½ per cent by weight of silver iodide to gunpowder.

It is hoped to test the relative effectiveness of the two methods of producing the particles by constructing a cold chamber as used by Vonnegut[3].

A full report on the results of the experiments will be prepared in due course.

D. A. Davies
(Director)

East African Meteorological Department,
P.O. Box 931, Nairobi.
March 5.

[1] Langmuir, I., *Science*, **112**, 35 (1950).
[2] Vonnegut, B., General Electric Research Lab. Occas. Report No. 13 (1949).
[3] Vonnegut, B., *Chem. Rev.*, **44**, No. 2, 277 (1949).

The Ångström

May I reply to Mr. Twyman's letter in *Nature* of February 10, p. 245? The Swedish alphabet has twenty-eight letters, of which 'Å' is the twenty-sixth. This letter is not a modified 'A'. The relation of 'Å' to 'A' is somewhat analogous to that of 'W' to 'U'. Unfortunately, the British Committee of 1937, oblivious of this, recommended the use of 'A' as an abbreviation for the ångström. The half-dozen examples quoted by Mr. Twyman of the use of 'A' in reports and books written in English since 1937 merely show that the recommendation of this Committee has quite naturally been followed.

There will soon appear two English reports on symbols superseding that of 1937. One of these is sponsored by the Royal Society, the Chemical Society, the Faraday Society and the Physical Society; the other is sponsored by the British Standards Institution. Until these new reports are published, I cannot state with complete certainty what symbol they will recommend for the ångström. I can, however, affirm that both Committees charged with preparing these reports are aware of the distinction between the letters 'Å' and 'A' in Swedish, and further that it is the declared policy of both these Committees as far as possible to conform with internationally accepted usage. Both the International Union of Pure and Applied Physics (1948) and the International Union of Pure and Applied Chemistry (1949) have adopted 'Å' as the abbreviation for the ångström, and 'A' as the abbreviation for the ampere. I fail to see in what respect it might be considered "retrograde" to align ourselves with other nations and at the same time to repair an unintentional error.

E. A. Guggenheim

The University,
Reading.
Feb. 16.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, April 16

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Public Lighting" (to be opened by Mr. E. H. Jesty).

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Mr. A. L. Bacharach: "Animals as Laboratory Reagents".*

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Sir Clarmont Skrine: "Recent Economic Developments in Israel".

Tuesday, April 17

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Mr. W. D. Seymour: "The Nature and Acquisition of Industrial Skills".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Humidity Measurement and Control" (to be opened by Dr. L. Hartshorn and Prof. H. S. Gregory).

SOCIETY OF CHEMICAL INDUSTRY, CROP PROTECTION PANEL of the AGRICULTURE GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. F. C. Bawden, F.R.S.: "Some Factors affecting the Spread of Plant Virus Diseases".

INSTITUTE OF PETROLEUM, NORTHERN BRANCH (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. R. D. Streeton and Mr. A. C. Mauchan: "Alloyed Oils".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Dr. E. M. Evans: "Cashew Nut Shell Liquid and its Applications".

SHEFFIELD METALLURGICAL ASSOCIATION (at the Grand Hotel, Sheffield), at 7 p.m.—Dr. N. P. Allen: "Metallurgical Research at the National Physical Laboratory".

Wednesday, April 18

ASSOCIATION OF APPLIED BIOLOGISTS (in the Mining Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 11.15 a.m.—Scientific Papers.

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir John Hacking: "Electricity Supply in Great Britain To-day" (Llewelyn B. Atkinson Lecture).

PHYSICAL SOCIETY, COLOUR GROUP (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 3.30 p.m.—Mr. A. Dinsdale: "Some Colour Problems in Ceramics".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Annual General Meeting; at 5.30 p.m.—Dr. E. G. Bowen: "Cloud Physics".

COUNCIL FOR THE PROMOTION OF FIELD STUDIES (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Discussion on "The New Approach to Natural History" (to be opened by Sir Arthur Tansley, F.R.S.).

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. H. Leyburn and Mr. C. H. W. Lackey: "The Protection of Electrical Power Systems, a Critical Review of Present-day Practice and Recent Progress".

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Discussion on "Binocular Microscopes".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Dr. R. G. Tomkins: "Microbiological Problems in the Preservation of Fruit and Vegetables".

INSTITUTION OF WORKS MANAGERS, WEST MIDLAND BRANCH (joint meeting with the Institute of Cost and Works Accountants and the Institution of Production Engineers, at the James Watt Memorial Institute, Birmingham), at 7 p.m.—Mr. W. C. Puckey: "The Measurement of Productivity".

ROYAL STATISTICAL SOCIETY, NORTH-EASTERN GROUP of the INDUSTRIAL APPLICATIONS SECTION (at the Chemical Industry Club, 18 Lovain Place, Newcastle-upon-Tyne), at 7 p.m.—Mr. J. M. Runcie: "Statistics in Coal Technology".

Wednesday, April 18—Saturday, April 21

ERGONOMICS RESEARCH SOCIETY (at The University, Birmingham).—Symposium on "Human Factors in Equipment Design".

Thursday, April 19

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 10.30 a.m.—Discussion on "Friction" (to be opened by Mr. F. P. Bowden, F.R.S.).

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. H. W. Turnbull, F.R.S.: "Early Mathematical Discoveries of Newton".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.15 p.m.—Prof. David Williams and Dr. F. M. Nakhla: "Chromographic Contact Print Method of Examining Metallic Minerals and its Applications".

Friday, April 20

ROYAL SOCIETY OF MEDICINE, EPIDEMIOLOGY AND STATE MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 4.30 p.m.—Discussion on "Social Medicine" (to be opened by Mr. A. Blenkinsop, M.P., Dr. G. O. Barber and Dr. J. Greenwood Wilson).

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL GROUP (at the Albert Hall, Peter Street, Manchester), at 6 p.m.—Mr. R. G. Hooker: "Production Statistics".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, SCOTTISH SECTION (at the North British Hotel, Edinburgh), at 7 p.m.—Mr. G. Rattray: "The Microscope as an Analytical Aid".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7.30 p.m.—Dr. J. G. Fife: "The Patents Act, 1949, in relation to the Fine Chemicals Industry".

Saturday, April 21

BRITISH INTERPLANETARY SOCIETY, NORTH-WESTERN DISTRICT CENTRE (at the Adult Education Institute, 49 Lower Mosley Street, Manchester), at 7 p.m.—Mr. H. L. Dilks: "The Planet Mars"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHEMIST at the Central Laboratory, Chiswick, to be responsible for the work of a section dealing with paints and surface protection in general—The Staff Officer, London Transport Executive, 55 Broadway, London, S.W.1, quoting F/EV.168 (April 21).

LECTURER IN PHYSICS at Coventry Technical College—The Director of Education, Council House, Coventry (April 21).

SCIENTIFIC OFFICER IN THE AGRICULTURAL ENTOMOLOGY RESEARCH DIVISION of the Ministry of Agriculture—The Secretary, Civil Service Commission, Stormont, Belfast (April 23).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree, or equivalent, in science) to take charge of a Ministry of Supply Central Technical Information Bureau in London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.127/51A (April 28).

ANALYST (including micro-analysis) IN THE CHEMISTRY DEPARTMENT—The Secretary, The University, Aberdeen (April 30).

ASSISTANT LECTURER IN GEOLOGY, with qualifications either in stratigraphy or palæontology—The Registrar, The University, Manchester 13 (April 30).

I.C.I. RESEARCH FELLOWSHIPS IN PHYSICS, CHEMISTRY, METALLURGY, ENGINEERING or in allied subjects—The Registrar, University of Wales, University Registry, Cathays Park, Cardiff (April 30).

LECTURER, and a DEMONSTRATOR, IN PHYSIOLOGY—The Secretary, London Hospital Medical College, Turner Street, London, E.1 (April 30).

LECTURER IN STRATIGRAPHY and a LECTURER IN PETROLOGY—The Registrar, The University, Manchester 13 (April 30).

SENIOR LECTURER IN BIOCHEMISTRY in the Veterinary School—The Secretary of University Court, The University, Glasgow (April 30).

SENIOR LECTURER and ASSISTANT LECTURERS (2) IN PHYSIOLOGY—The Secretary of University Court, The University, Glasgow (April 30).

CHAIR OF MEDICINE—The Secretary, Queen's University, Belfast (May 1).

ASSISTANT LECTURER IN METALLURGY—The Registrar, The University, Manchester 13 (May 5).

BRITISH COKE RESEARCH ASSOCIATION FELLOWSHIP—The Registrar, King's College, Newcastle-upon-Tyne (May 5).

PROBATIONARY ASSISTANT LECTURER IN BOTANY, and a RESEARCH DEMONSTRATOR IN BOTANY AND ZOOLOGY—The Registrar, University College, Singleton Park, Swansea (May 5).

ASSISTANT LECTURERS IN BACTERIOLOGY, CHEMISTRY, CIVIL ENGINEERING, PSYCHOLOGY, ZOOLOGY, HISTORY and LAW—The Secretary, Queen's University, Belfast (May 15).

JUNIOR LECTURERS IN PURE or APPLIED MATHEMATICS—Prof. E. Titchmarsh, Mathematical Institute, Radcliffe Science Library, Oxford (May 19).

COATS FELLOWSHIP IN CHEMISTRY or PHYSICS—The Clerk of Senate, The University, Glasgow, W.2 (May 31).

PRINCIPAL RESEARCH OFFICER or SENIOR RESEARCH OFFICER (Ref. No. 3345), to carry out investigations into the coke-gas-and-by-product-making properties of Australian coals, and to be responsible for the work of the section dealing with the carbonizing of coal, a PRINCIPAL RESEARCH OFFICER or SENIOR RESEARCH OFFICER (Ref. No. 3346), to conduct investigations into the chemistry of coal and to assist in the direction of the work of technical staff engaged on a comprehensive survey of the chemical properties of coal, and a PRINCIPAL RESEARCH OFFICER or SENIOR RESEARCH OFFICER (Ref. 3347), to conduct fundamental investigations on the physical properties of Australian coals and of the cokes made therefrom, and to be responsible for the work of the section dealing with these investigations, in the Coal Research Section of the Commonwealth Scientific and Industrial Research Organization, Chatswood, New South Wales—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (May 31).

SENIOR LECTURER IN MECHANICAL ENGINEERING at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 4).

SIR THOMAS LYLE FELLOWSHIP IN PHYSICS at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 4).

ASSISTANT LECTURER AND DEMONSTRATOR IN BACTERIOLOGY—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

GRADUATE, for work in the Tinplate Department—The Director, Tin Research Institute, Fraser Road, Perivale, Greenford, Middx.

JUNIOR PHYSICIST—The Secretary, Bristol Mental Hospital, Fishponds, Bristol.

LECTURER IN HORTICULTURE, and ASSISTANT LECTURERS IN PSYCHOLOGY, MATHEMATICS (pure or applied), GEOLOGY, and GEOGRAPHY—The Registrar, The University, Nottingham.

MATHEMATICIANS to study theoretical problems connected with the design and performance of nuclear reactors and atomic energy plants—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

PHYSICAL CHEMIST or PHYSICIST for research into application of ultrasonics to problems of detergency—The Director, British Launderers' Research Association, The Laboratories, Hill View Gardens, London, N.W.4.

PHYSICIST or PHYSICAL CHEMIST (honours graduate) to work initially on problems of using rubber in road surfacings—The Director of Research, British Rubber Producers' Research Association, 48–52 Tewin Road, Welwyn Garden City, Herts.

RESEARCH SCHOLARSHIPS tenable in the Department of Chemistry, Colour Chemistry and Dyeing and/or other Departments—The Principal, Technical College, Queen Street South, Huddersfield.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Journal of the Transactions of the Victoria Institute or Philosophical Society of Great Britain. Vol. 81, 1949. Pp. xvi+214. (London: Victoria Institute, 1950.) 15*s.* [512

British Standard 1619:1950, Hypodermic Syringes for Insulin Injection. Pp. 21. (London: British Standards Institution, 1950.) 2*s.* 6*d.* net. [512

Department of Scientific and Industrial Research. Report of the Fuel Research Board, with the Report of the Director of Fuel Research, for the Period 1st April 1939 to 31st March 1946. Pp. vi+69+12 plates. (London: H.M. Stationery Office, 1950.) 3*s.* net. [712

Parliamentary and Scientific Committee. Productivity: Summary of a Discussion at a Meeting of the Committee at the House of Commons, 7 November 1950. Pp. 24. (London: Parliamentary and Scientific Committee, 1950.) 1*s.* 3*d.* [1912

Report of the Interdepartmental Committee on Social and Economic Research. (Cmd. 8091.) Pp. iv+14. (London: H.M. Stationery Office, 1950.) 6*d.* net. [2912

National Research Development Corporation. Report and Statement of Accounts for the Period 28th June 1949 to 30th June 1950. Pp. 20. (London: H.M. Stationery Office, 1950.) 6*d.* net. [91

National Parks and Access to the Countryside Act, 1949. First Report of the National Park Commission for the Period ending 30th September 1950. Pp. iv+8. (London: H.M. Stationery Office, 1950.) 4*d.* net. [91

Fourth World Power Conference, London, 10–15 July 1950. Report of the Discussion on Section J, Atomic Energy. Pp. 21. (London: World Power Conference, 1950.) 2*s.* [111

Linen Industry Research Association. Report of the Council, 1950. Pp. 20. (Lambeg, Co. Antrim: Linen Industry Research Association, 1950). [111

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 860, Vol. 243: Excitation and Ionization of Atoms by Electron Impact—The Born and Oppenheimer Approximations. Part 1, by D. R. Bates, A. Fundaminsky and H. S. W. Massey; Part 2, by D. R. Bates, A. Fundaminsky, J. W. Leech and H. S. W. Massey. Pp. 93–144. 12*s.* No. 861, Vol. 243: Calcium Carbonate and its Hydrates. By R. Brooks, L. M. Clark and E. F. Thurston. Pp. 145–168. 7*s.* (London: Cambridge University Press, 1950.) [111

West Norfolk Farmers Manure and Chemical Co-operative Company, Ltd. Annual Circular. Pp. 34. (King's Lynn: West Norfolk Farmers Manure and Chemical Co-operative Co., Ltd., 1950.) [111

Mushroom Science, 1: Proceedings of the First International Conference on Scientific Aspects of Mushroom Growing, held at Peterborough, 3rd to 11th May 1950. Pp. 112. (Yaxley: Mushroom Research Association, Ltd., 1950.) 7*s.* 6*d.* [111

British Institute of Management. Production Management Series 1: Production Control in the Small Factory. Revised edition. Pp. 30. (London: British Institute of Management, 1951.) 2*s.* 6*d.* [151

Report upon the Work of the Government Chemist for the Year ending 31st March 1950. Pp. 36. (London: H.M. Stationery Office, 1950.) 1*s.* net. [151

Department of Scientific and Industrial Research. Report of the Chemistry Research Board with the Report of the Director of the Chemical Research Laboratory for the Year 1949. Pp. vi+96. 3*s.* net. Report of the Building Research Board with the Report of the Director of Building Research for the Year 1949. Pp. iv+60+16 plates. 3*s.* net. Report of the Radio Research Board for the period 1st October 1933 to 31st December 1948 with a Survey of the Investigations carried out during the Years 1934–1947 and Report of the Director of Radio Research for the Year ended 31st December 1948. Pp. iv+60+8 plates. 2*s.* net. (London: H.M. Stationery Office, 1950.) [151

Committee of the Privy Council for Agricultural Research and Nature Conservancy. Pp. ii+6. (London: Nature Conservancy, 1950.) [151

British Chemicals and their Manufacturers: the Directory of the Association of British Chemical Manufacturers. Pp. 169. (London: Association of British Chemical Manufacturers, 1951.) Free. [151

Chelsea Polytechnic. Fifty-fifth Annual Report, Session 1949–50. Pp. 24. (London: Chelsea Polytechnic, 1950.) [151

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 862, Vol. 243: A Thermodynamical Investigation of the System Benzene–Diphenyl. Part 1, by J. H. Baxendale, B. V. Enüstün and J. Stern; Parts 2, 3 and 4, by J. H. Baxendale and B. V. Enüstün. Pp. 169–196. (London: Cambridge University Press, 1951). 6*s.* 6*d.* [151

Other Countries

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Rapport Annuel pour l'exercice 1949. Pp. 306. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1950.) 150 francs. [512

Indian Forest Bulletin No. 148: Utilisation of Bagasse for Wrapping and Rag-Paper. By M. P. Bhargava, Dr. G. S. Kasbekar and R. P. Bhargava. Pp. ii+18. (Dehra Dun: Forest Research Institute, 1950.) 10 annas; 1*s.* [512

The Four Directions of Time: an Account of Page One of Codex Fejervary Mayer (a Pre-Columbian Manuscript) in the Free Public Library and Museums, Liverpool. By C. A. Burland. Pp. 16. (Santa Fe, New Mexico: Museum of Navajo Ceremonial Art, 1950.) [512

Malayan Fisheries: a Handbook prepared for the Inaugural Meeting of the Indo-Pacific Council, Singapore, March 1949. Edited by Dr. G. L. Kesteven. Pp. viii+88+17 plates. (Singapore: Commissioner-General for United Kingdom in South-East Asia, 1949). [111

Universidade do Brasil: Museu Nacional. Atividades cientificas em 1949. Pp. 41. (Rio de Janeiro: Universidade do Brasil, 1950.) [111

Chemical-Biological Coordination Center. Review No. 3: Histamine Antagonists. By Frederick Leonard and Charles P. Huttrer. Pp. 122. (Washington, D.C.: National Research Council, 1950.) 1.50 dollars. [111

Ministry of Commerce and Industry: Mines and Quarries Department, Geological Survey. The Geology of the Iron-Ore Deposits of Egypt. By M. I. Attia. Pp. iv+34. (Cairo: Government Press, 1950.) [111

Annales Bogorienses. A Journal of Tropical General Botany, being a continuation of the Annals of the Botanic Gardens, Buitenzorg. Vol. 1, No. 1, October. Pp. ii+52. (Bogor: Kebun Raya Indonesia, 1950.) 1.50 U.S. dollars. [111

The Velocity of Light and the Light Universe. By Sri Tarak Nath Sen. Motion and Light make for us a Limited Objective World of Light-and-Sight within an Infinite Universe. Pp. iii+21. The Linear and the Angular Motions of Light. Pp. 16. (Dacca: The Author, 87/1 Tanti Bazar, n.d.) [111

Rubber Research Institute of Malaya. Report for the Period January 1941 to August 1945. Pp. ii+108. (Kuala Lumpur: Rubber Research Institute of Malaya, 1950.) [111

Survey of Egypt. Survey Department Paper No. 49: The Egyptian Desert and its Antiquity. By G. W. Murray. Pp. 22. Survey Department Paper No. 50: The Survey of Egypt, 1898–1948. Edited by G. W. Murray. Pp. v+94. (Cairo: Government Press, 1950.) [111

Memoirs of the Commonwealth Observatory. Memoir No. 10: Measurements of the Intensity of Cosmic Rays. By A. R. Hogg. Pp. viii+100. (Mt. Stromlo, Canberra: Commonwealth Observatory, 1949.) [111

Western Australia: Geological Survey. Bulletin 101: Maps, Plans, and Sections to accompany Report on the Mining Groups of the Yilgarn Goldfield north of the Great Eastern Railway. Plates 1–36. (Perth: Government Printer, 1950.) [111

Internationale Zeitschrift für Orgonomie. Offizielles Organ der Orgone Institute Research Laboratories. Band 1, Heft 1, April. Pp. 48. (Tel Aviv: Martin Feuchtwanger; London: Biotechnic Press, Ltd., 1950.) 7*s.* 6*d.*; subscription for 4 numbers, 25*s.* [111

Kungl. Sjökarteverket. Ergebnisse der Beobachtungen des Magnetischen Observatoriums zu Lovö (Stockholm) im Jahre 1947. Von Nils Arnbolt. Pp. 32. (Stockholm: Kungl. Sjökarteverket, 1950.) [111

Sugar in Public Health. Discussion by Dr. Robert C. Hockett, Scientific Director, Sugar Research Foundation, Inc., November 2, 1950. Symposium sponsored by Dental Health and Food Nutrition Sections. Pp. 32. (St. Louis, Mo.: American Public Health Association, 1950.) [151

Unesco. Publication 619: Directory of International Scientific Organizations. Pp. xiii+224. (Paris: Unesco; London: H.M. Stationery Office, 1950.) 1 dollar; 6*s.*; 300 francs. [151

Catalogues

Elcontrol News. No. 2, November 1950. Pp. 4. (London: Elcontrol, Ltd., 1950.)

A Century of Progress, 1850–1950. Pp. 36. (Chadwell Heath: Hopkin and Williams, Ltd., 1950.)

The Aluminium Courier. No. 13, September 1950. Pp. 12. (London: Aluminium Development Association, 1950.)

Cambridge Direct-Writing Polarograph. (Sheet No. 302). Pp. 2. (London: Cambridge Instrument Co., Ltd., 1950.)

Ediswan Microfilm Readers. Pp. 4. (London: Edison Swan Electric Co., Ltd., 1950.)

Catalogue of Books on Psychology, Psychoanalysis and Allied Subjects. Pp. 44. Catalogue of Books on Geology, Mineralogy and Mining. Pp. 16. (London: H. K. Lewis and Co., Ltd., 1951.)

Torque Characteristics of F.H.P. Squirrel-Cage Motors. (Publication 10/10–1). Pp. 4. Voltage Regulating Relays and Line Drop Compensator, for the Automatic Regulation of Voltage. (Publication 341/42–1). Pp. 4. Electron Diffraction Camera. (Publication 905/9–1). Pp. 2. Single-Phase Light Power Motors. (Publication 10/16–1). Pp. 2. Single-Phase Repulsion-Induction Motors. (Publication 22/1–1). Pp. 4. Industrial Electric Timer. (Publication 85/17–1). Pp. 4. Auto-Transformer Contactor Starters. (Publication 90/15–1). Pp. 2. A.C. Contactor Starters for Electric Capstans and Winches. (Publication 91/8–1). Pp. 2. Electronic Control Equipments for A.C. Systems. (Publication 98/4–1). Pp. 4. Rotary Synchroscopes. (Publication 345/20–1). Pp. 4. Motor-Generator Set for Trolleybus Service. (Publication 579/12–1). Pp. 2. Vehicle Heater Unit. (Publication 579/29–1). Pp. 2. 'Thermac' Single-Operator Moving Coil Transformer Arc Welding Equipment. (Publication 783/17–1). Pp. 2. (Manchester: Metropolitan-Vickers Electrical Co., Ltd., 1951.)

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